The AMSAT Journal

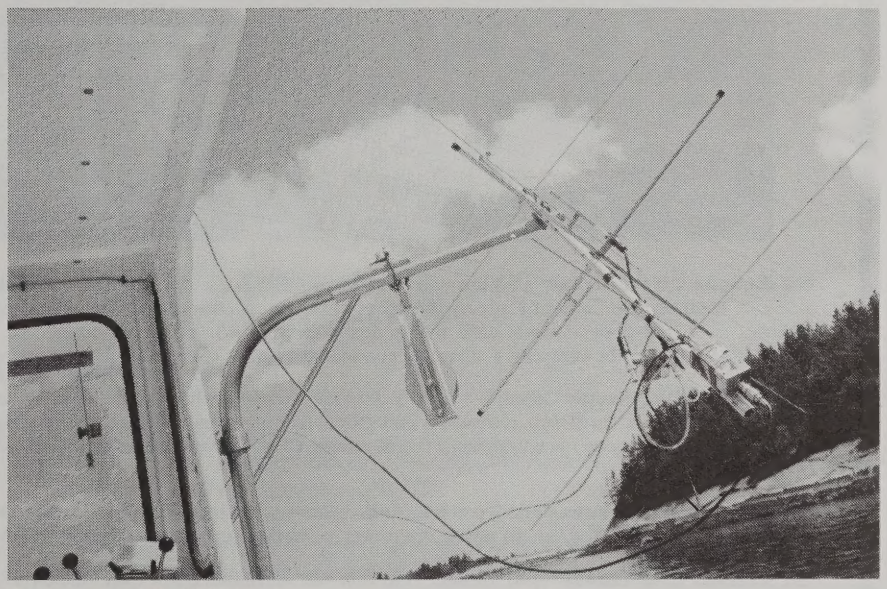
Incorporating the AMSAT Newsletter
Volume 14 No. 2 March 1991

Editor: ***Drew Deskur, KA1M***
Managing Editor: ***Robert M. Myers, W1XT***

Marine Mobile QSOs Via OSCAR 13 (Mode Sea?)

Saturday, 14 July 1990, off the coast of Maine in a 27 foot lobster boat, the Sea Heather: *"CQ OSCAR 13, this is WB1BRE, Whiskey Bravo One Bravo Romeo Echo-Mobile Marine calling CQ and standing by."*

By William Burden, WB1BRE
11 Briand Drive
Nashua, NH 03063



(All photos by KA1LDS)

My Marine Mobile CQ was followed by carriers swooping in on my frequency and a jumble of calls, mostly from folks who weren't quite sure what they heard, but followed the rule of "make contact first, then figure it out!" What, you may ask, got me to the point where I am standing in the cabin of a little lobster boat (my sister's) a mile at sea off the small fishing village of Corea in Maine.

I started in satellites about five years ago and worked from LEO birds to OSCAR 13 with a fixed station at home in NH. During those five years, I got interested in portable and battery operation and developed that capability in most aspects of Amateur operating including repeater, packet and low band work. The extension of portable operation to OSCAR came within reach when OSCAR 13 became operational. The sensitivity of the bird's receiver and the downlink signal levels put OSCAR 13 within reach of an Earth station of limited size and power.

I started putting together a portable station and testing it at both our homes in NH and in Vermont a couple of years ago. During those two years I took on the challenge of searching out the simplest portable station (of modest cost) that I could put together. I have a Ford pickup and started using that to carry the station and antennas. The first antenna set was the Cushcraft AOP-1 pair on a Radio Shack tripod with all the rotating and elevating done manually. Rigs were the next problem — we have a Uniden 10M rig in the truck and so I started to think about a 2/10M downconverter for the receive side.

About that time a friend in NH put his TenTec 2510 Mode B satellite station on the market and contacted me to see if I might be interested! Bingo, just what I needed for the station! The TenTec rig combines a 2/10M downconverter with a 10W, 435 SSB/CW transmitter with tracking VFO's. And it operated from 12V DC!

So I integrated the two rigs and wired up a harness to run the TenTec off the truck battery. Next was the issue of coax cables to the antennas. Do I get 9913 for the uplink and 213 on the receive side? Hold it, this is a low cost project! So, off to Radio Shack for 12 ft. of their best RG-8 for the uplink and 20 ft. of RG-58 for the receive side! Now, before you get excited remember that my antenna is 6-10 ft. from the rig. I could run zipcord on the receive side and still get reasonable signals on the downlink! And besides, if I wreck or lose a coax cable oper-

(Continued on page 4)

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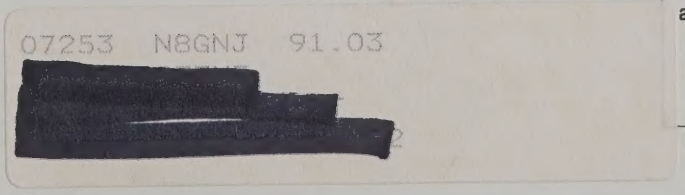
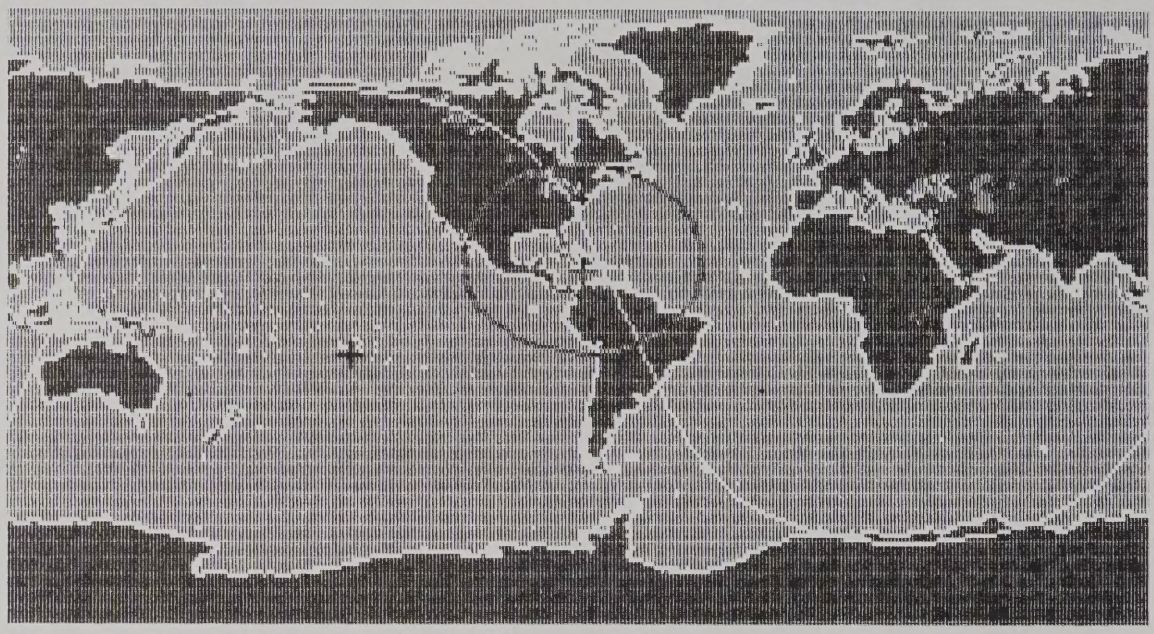


Satellite Tracking

with your PC and the Kansas City Tracker & Tuner



The **Kansas City Tracker** is a hardware and software package that connects between your rotor controller and an IBM XT, AT, or clone. It controls your antenna array, letting your PC track any satellite or orbital body. The **Kansas City Tracker** hardware consists of a half-size interface card that plugs into your PC. It can be connected directly to Kenpro 5400A/5600A or Yaesu G5400B/G5600B rotor controllers. It can be connected to other rotor assemblies using our Rotor Interface Option.

The **Kansas City Tuner** Option provides automatic doppler-shift compensation for digital satellite work. The **Tuner** is compatible with most rigs including Yaesu, Kenwood, and ICOM. It controls your radio thru the radio's serial computer port (if present) or through the radio's up/down mic-click interface. The **Kansas City Tuner** Option is perfect for low-orbit digital satellites like the NOAA and Microsat satellites.

The **Kansas City Tracker** and **Tuner** include custom serial interfaces and do not use your computer's valuable COMM ports. The software runs in your PC's "spare time," letting you run other programs at the same time.

The **Kansas City Tracker** and **Tuner** programs are "Terminate-and-Stay-Resident" programs that attach themselves to DOS and disappear. You can run other DOS programs while your antenna tracks its target and your radios are tuned under computer control. This unique feature is especially useful for digital satellite work; a communications program like PROCOMM can be run while the PC aims your antennas and tunes your radios in its spare time. Status pop-up windows allow the user to review and change current and upcoming radio and antenna parameters. The KC Tracker is compatible with DOS 2.00 or higher.

Satellite and EME Work

The **Kansas City Tracker** and **Kansas City Tuner** are fully compatible with N4HY's QUIKTRAK and with Silicon Solution's GRAFTRAK. These programs can be used to load the **Kansas City Tracker's** tables with more than 50 satellite passes.

DX, Contests, and Nets

Working DX or contests and need three hands? Use the **Kansas City Tracker** pop-up to work your antenna rotor for you. The **Kansas City Tracker** is compatible with all DX logging programs. A special callsign aiming program is included for working nets.

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The **Kansas City Tracker** comes complete with special control programs that allow the packet BBS user or control-op to perform automated antenna aiming over an hour, a day, or a week. Your BBS or packet station can be programmed to automatically solicit mail from remote packet sites.

Vision-Impaired Hams

The **Kansas City Tracker** has a special morse-code sender section that will announce the rotor position and status automatically or on request. The speed and spacing of the code are adjustable.

The **Kansas City Tracker** and **Tuner** packages include the PC interface card, interface connector, software diskette, and instructions. Each Kansas City unit carries a one year warranty.

- KC Tracker package for the Yaesu/Kenpro 5400A/5600A controller $189
- Interface cable for Yaesu/Kenpro 5400A/5600A ..... $ 19
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- KC Tuner Option ..... $ 79
- N4HY QuikTrak software ..... $ 80

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This issue of *The AMSAT Journal* emphasizes the SAREX Missions. Here's the crew for STS-37: (front l. to r.) Ken Cameron, Steven Nagel, Linda Godwin, (rear) Jay Apt and Jerry Ross.

ating portable somewhere the probability of finding a Radio Shack within easy driving distance is very high!

I started experimenting both in Vermont and at my home QTH in Nashua with the setup and quickly found that I needed more than 10W on the uplink to get a comfortable downlink signal. So I grabbed the 60W Tokyo Labs linear (12V) from my home satellite station and hooked it in. Much better!

The final piece for the station was the battery for stand-alone operation. I bought an 80 AHr deep-cycle battery designed for electric outboard motor operation. This type is most suitable for operating radios as it is designed to provide constant power over a long period of time as opposed to regular auto batteries that are optimized to provided lots of Amps for seconds during startup. The battery has a built-in carrying handle which makes it very convenient for moving around.

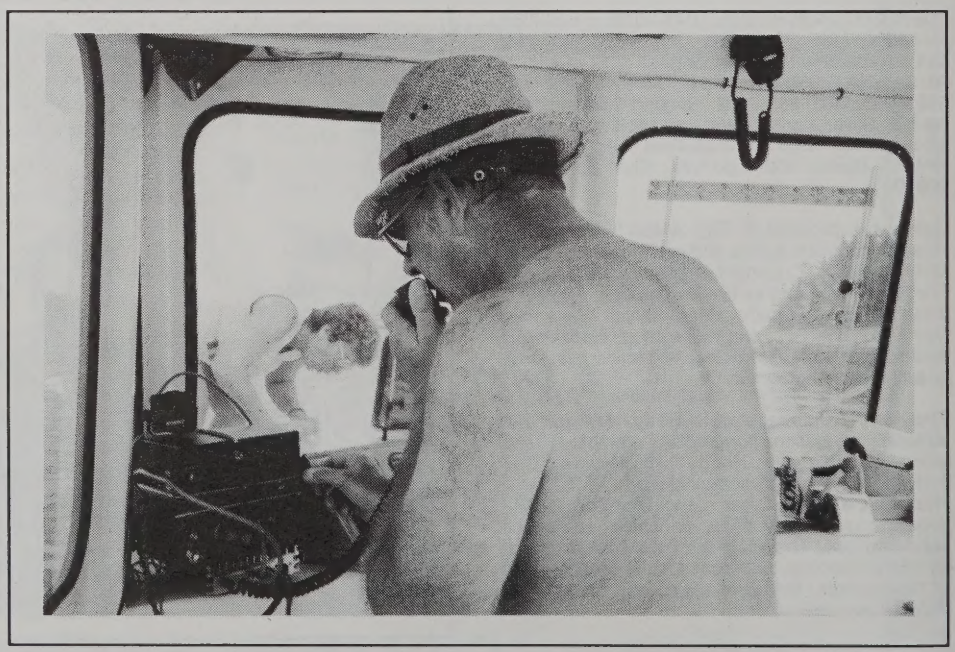
I brought the station to work several times and set it up during the noon hour in the parking lot. Along with making many good contacts, I got to know the plant security guards who were investigating reports of a "spy station" in the parking lot! (*Editor's note: Bill works for a company which does a lot of government contract work.*)

At this stage of the experiment, I started looking for the minimum receive antenna I could use. I had talked to operators who were using 6-10 element antennas on receive and having pretty good results. One day on the way home from work I tied the TenTec into the 2M quarterwave whip in the roof of the truck and monitored the OSCAR 13 beacon as I proceeded down the highway. With the bird near apogee I was surprised to find that I could hear the beacon quite well! I reasoned if one quarterwave piece of wire was marginal then four quarterwave lengths must be better!! So, I committed to the cost of an SO-259 connecter, some loose wire, a wooden base, and other material to make a 2M quad loop. I set it on top of the aluminum cap on the truck in my driveway and I got useable signal levels on the downlink! An important note: I did not have a GaAsFET preamp at this point. I made many contacts and had good luck with the quad antenna as long as the bird was at least 45 degrees above the horizon.

Now to the transmit antenna. I had picked up another KLM 18C by now and replaced the Cushcraft uplink antenna. I found that the ability to switch polarization on the uplink antenna was very important; you need all the margin you can get in portable operation. Unfortunately, the 18C is not quite in the category of a portable antenna! So, back to the drawing board!

Hearing several folks on the air with helix designs on the uplink antennas, I tried inverse reasoning and said that if a 12 turn helix was very good, then a 3 turn helix must be kind of OK! Well, anyway it was small! I resurrected an old wooden drafting board from the days of Mechanical Drawing 101 (yes, we actually once used pencils to make drawings!), covered it with some sticky-backed copper foil I had been saving for years (metal screening will do just as well), and bought (arrrrgg) $1.85 worth of 1/8-inch copper pipe and another SO-259 connector. I wound the spiral and held it in a simple wooden frame work in the middle of board. Three turns looks like about 8 dB of gain according to the *Antenna Handbook*, so with 50-60 Watts, I was still able to put out a reasonable signal! Now it looked more like a portable satellite station antenna setup — wooden structures, #14 copper wire stripped from house wiring, copper plumbing pipe and a discarded drafting board! My Scottish ancestors were cheering from their graves!!

In this same time period I was doing many club presentations on satellite operations and started introducing the concept of minimal antennas and cheap coax. I then discovered that this was beginning to startle some satellite ops who, after spending many dollars and many hours optimizing both uplink and downlink systems in their own stations, found this nut running around preaching Radio Shack coax and plumbing supply antennas! I hasten to say that I would actually be in their camp, since I had spent a year and a half getting



my original home station optimized and still struggle to get to that next level on the ZRO tests to see if I can squeak out a few more dB on the receive side.

But not to fear — it becomes clear very quickly to portable operators of "low-performance" stations like mine that there are many limitations to your capability. You are limited by your battery capacity when operating at remote sites, and the position of the satellite and level of activity, since you are definitely not a big signal under any conditions! But you also find out that "CQ — Vermont/battery portable" or "CQ — Maritime mobile" gets you at least 10dB of advantage automatically! So you have to pick time, place and circumstance carefully to light off the portable station with any expectation of success.

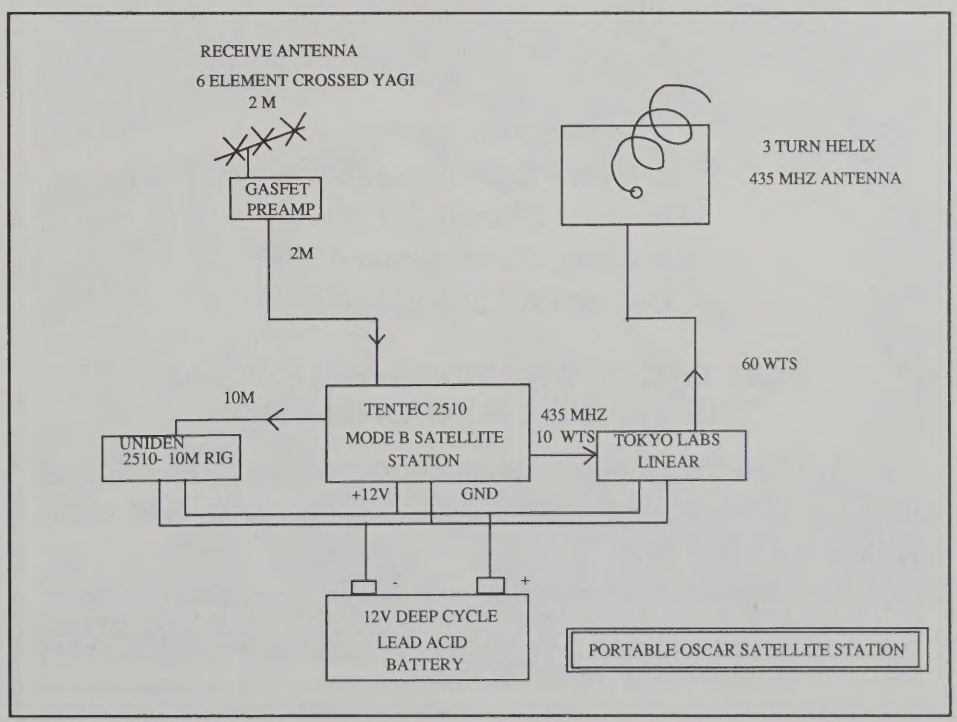
But, what about the lobster boat operation, you say!? Dot, KA1LDS, and I were in Maine visiting my sister for a long weekend and I had filled the car with the antennas, satellite station, batteries, etc. and we were ready for a few days of salt air, trips on her new lobster boat and satellites! Well, we rolled in to Corea on a Friday and immediately set about installing the station. I installed the rigs on the shelf next to the depth sounder and found a spot on the deck for the battery. The power cable wasn't quite long enough, so I put the battery on an old plastic milk crate and hoped that the boat didn't take any bad rolls! For the receive antenna, I used a section of the old Cushcraft 2M crossed Yagi (3X3 elements) and mounted it on the swing-out davit on the starboard side. I had considered using the quad loop antenna, but decided that I would like to insure good receive signal levels for this experiment, so opted for the Yagi. By now I had acquired a Hamtronics GaAsFET preamp (the lowest cost one, of course) and installed it with a 9V battery in a small metal box attached with black tape to the receive antenna. The installation of the transmit antenna was much simpler. I simply put the 435 helix on the stern deck and shimmed it up with anything handy to point it in the general direction of the bird. Both antennas have 40-60 degree beamwidths, so pointing is not critical. Also, the small size and portability of the antennas made it very easy to manually change elevation or azimuth as the situation dictated.

A quick check of the satellite track printout and a signal check at the mooring to insure that all was working and off we went to the Atlantic Ocean! Well, actually about a mile off shore we threw out a sea anchor and drifted in the lee of a small island to avoid any major wave action. Fortunately, the wind was out of the North and AO-13 was in a northerly direction, so

we used the boat as the azimuth control! We planned it all so that the bird was approaching apogee when I started calling CQ to get the most favorable performance period. Well, my first contact was ON1LVL and he must have spread the word, because the frequency got very busy. I made six more contacts over the next 30 minutes and spent much time explaining the set up (see the drawing).

Things were really humming and then my sister Peg, who is a licensed Maine lobsterman (whoops — person), had pulled up one of her lobster pots in that area and was using it as additional drag to help hold the boat in position. About this time, we noticed a large power boat coming up on our stern. Didn't think much about it — it's a big ocean! Then we took a closer look and realized that it was a team of coastal patrol wardens bearing down on our floating satellite station. They pulled up alongside (love that nautical talk) and one asked "How's the TV reception?", followed by "We had some reports of funny goings-on out here", followed by "How come you've got that lobster pot on deck?"

Well, I began by explaining that I was an Amateur Radio operator (remembering that I had left my wallet with license on shore and couldn't prove it) and that this was an experimental Amateur satellite Earth station we were testing and we were talking to people all over the world, and that the



lobster pot was being used as a sea anchor for the boat! Then I paused, thought about it and said to the wardens "That's a hell of a story I'm asking you to believe, isn't it?" He looked at me for a moment and then they both started to laugh. They must have figured that nobody could concoct such a bizarre and ridiculous explanation for all this, so it must be true. One warden turned to my sister and said "Show me your marker float" (permanently attached to the lobster boat so that you can prove the pot you hauled is yours by comparing the floats). They matched and he said "OK, have a good day," cranked up the power boat and slid in to the harbor ahead of us. Peg then looked at me and said, "Boy, I'm glad he didn't ask any more questions, because I left my lobster license at the house"! (I wonder how well the portable station would have worked from the local jail? CQ — portable/prisoner!)

Back to Ham radio — more contacts with IKØHFA and G1IMM. We occasionally had to temporarily QRT to reposition the boat as it tended to drift toward the rocks and my sister would mumble something about just getting the boat all fixed up and I don't care if you are in the middle of a QSO, as she hit the starter button!

Some items to note on small boat operations. With the small antennas I was using and the resulting approximate 60 degree beamwidths, I was not affected by changes in elevation due to the rocking of the boat by the waves. Similarly, the boat did swing some on the sea anchor, changing the antenna azimuth by as much as plus and minus 20 degrees but again the wide beamwidth was a forgiving feature and the signal levels in both directions stayed pretty constant. On one occasion when the boat was in motion to reposition, we were moving very slowly and I was still in contact with a station. I didn't notice any signal level variations that disturbed the conversation, but we were moving in the direction of the satellite, so the azimuth and elevation positions were quite stable. It was a very short "sample time", but there was no indication of any "picket fencing" while in motion.

Weather and other considerations finally caused us to break off while the bird was still in Mode B and head back to the harbor and the mooring. Once we got tied up, I checked the deep-cycle battery and found we were still in good shape for operation. By now AO-13 was well on the way to perigee and we had about one hour of operating time left. I got on again and worked W5GEL, W1WXZ and FC1PAS. My final contact was Gene, VE1BB, from New Brunswick. Now, Gene and I have worked over the years and he has been following my portable antics as I have contacted him from Vermont, Pennsylvania, and NH at various times, so he is used to surprises! When I told him I was mobile/marine, he asked, "Are you in a rowboat?" (Gene was ready for anything!)

We didn't try any more operations that weekend, but I felt that I had convinced myself that a small portable station such as this one was fully capable of reasonable operation from a wide variety of sites and a wide range of circumstances. In addition, portable operations of DX-peditions around the world are confirming the great performance of AO-13, making it possible to "size down" a station for even more flexibility and fun. ■

Stations worked while operating as WB1BRE, Marine Mobile.

ON1LVL	KF6YM
DH2KAL	OE1WDC
DG3KBY	IKØHFA
W1WXZ	G1IMM
DG2SBW	W5GEL
WØDEN	FC1PAU
WD9EKU	VE1BB

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The Term "Hams in Space" Takes On a New Meaning

If NASA's current plans hold, in the next few weeks not ONE but FIVE licensed Radio Amateurs, an entire crew, will streak into space aboard the Shuttle.

By Bill Tynan, W3XO
Vice President for
Manned Space Programs

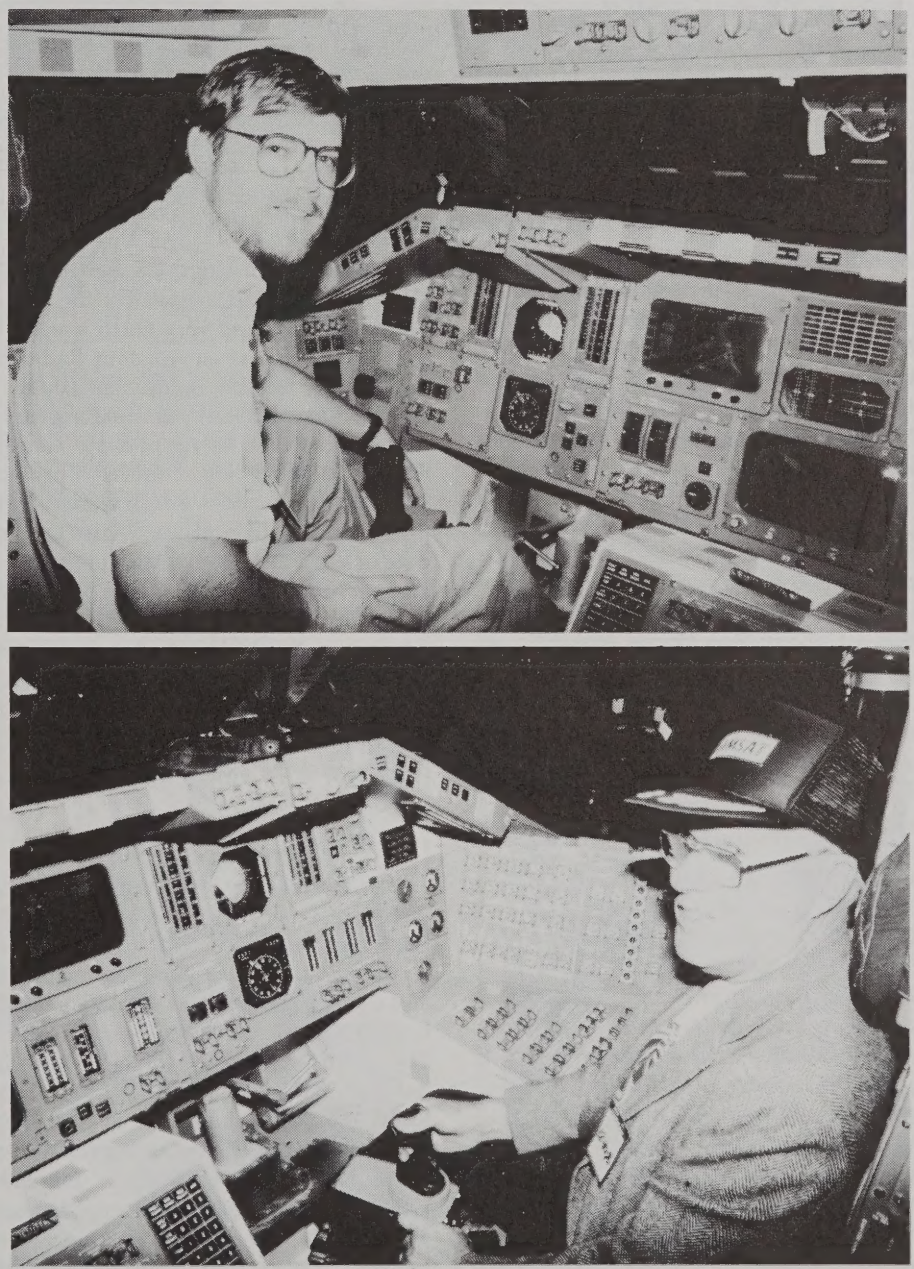
With the launch of Atlantis on Mission STS-37 Mission Commander Steve Nagel, N5RAW, Pilot Ken Cameron, KB5AWP, Mission Specialists Linda Godwin, N5RAX, Jay Apt, N5QWL, and Jerry Ross, N5SCW, will begin five days in space. The primary purpose of STS-37 is to deploy the Gamma Ray Observatory (GRO) spacecraft and conduct extra vehicular activities (EVAs) aimed at developing techniques for constructing the Space Station. But, we Hams will be particularly interested in what else the Atlantis crew are scheduled to be doing — operating the Shuttle Amateur Radio Experiment (SAREX) equipment.

The First Ham in Space

Most of us remember when Owen Garriott, W5LFL, blazed a new trail for Amateur Radio to become the first "Ham in Space" — when his Columbia vehicle was launched on Mission STS-9 in late 1983. The station he carried was simple; consisting of a Motorola 2 meter FM hand-held unit operating on its own batteries plus a few pieces of auxiliary equipment. Nevertheless, he thrilled us all as we lined up to try to contact an orbiting astronaut. Few DXpeditions to rare and exotic spots on the globe have brought forth such frenzied attempts for a QSO by so many. W5LFL ended up making several hundred two-ways with Amateurs throughout the world. But merely making contacts was not the principal benefit of the operation. It set the stage for more such "Ham in Space" operations to come. After failure to obtain permission for W5LFL to operate on Skylab several years earlier, AMSAT, this time, teamed up with ARRL to file a joint proposal for him to operate on STS-9. Following a favorable response from NASA officials, representatives from the League and AMSAT went to work to secure proper equipment and get it ready for flight. The Motorola Amateur Radio Club in Fort Lauderdale, Florida offered to make available several MX hand-held units along with special interface circuitry. Once the Motorola equipment was available, the Amateur Radio Club at the Johnson Space Center in Houston sprang into action to ready it for flight. This included conducting radio frequency interference (RFI) and many other tests as well as designing and constructing a suitable antenna that could be placed in a Shuttle window. Obtaining authority to run a cable to an outside antenna was deemed to be too difficult and represents a hurdle yet to be overcome.

WØORE Continues the Ham-in-Space Tradition

The success of Amateur operation from the Shuttle on STS-9 led to a similar attempt on STS-51F when Tony England, WØORE, was named to that mission's crew. This time the same basic team was augmented by Robot research and Panasonic to considerably enhance the capability of the orbiting Ham station by adding slow scan television (SSTV). When the Challenger lifted off



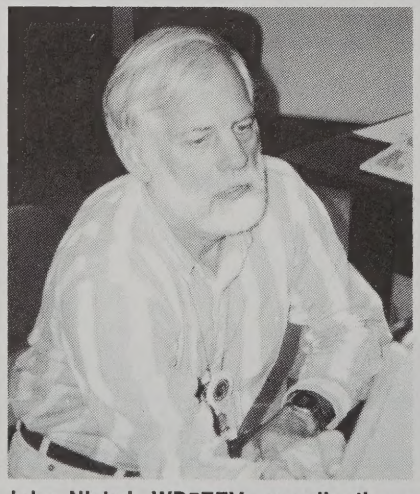
AMSAT President Doug Loughmiller, KO5I, (top) in the Commander's Seat and VP of Manned Flight Activities Bill Tynan, W3XO, in the Pilot's seat during a tour of the Shuttle Trainer in Houston, hosted by STS-37 pilot Ken Cameron, KB5AWP. (WB2D photo)

Roy Neal, Bill Tynan, Doug Loughmiller, and Mission Specialist Jay Apt conferring on Jay's upcoming flight. (WB2D photo)

in late July 1985, the second NASA-approved Amateur operation from space was underway. This time the effort was placed on voice contacts with schools as well as SSTV. Both were successful, with SSTV providing material for some outstanding sequences used in a post-flight video underwritten by the ARRL and narrated by Roy Neal, K6DUE.

Why Not Packet Radio in Space?

The genesis for the new SAREX experiment for STS-35 i.e. packet radio transmission came from talks which took place in 1985, involving Ron Parise, WA4SIR, an AMSAT member, and other AMSAT people including past President Tom Clark, W3IWI, and the author as AMSAT Vice President for Manned Space Programs. Ron had been chosen as a Payload Specialist on the Astro 1 Shuttle Mission and very much wanted to try packet radio as an Amateur Radio experiment if suitable equipment could be made ready and NASA permission secured. AMSAT resolved to support the concept and immediately began efforts to provide suitable equipment — which was ready in time to meet the then-planned Astro 1 launch date of March 1986. As it had for the STS-9 and STS-51F missions, AMSAT took the lead in drafting a joint AMSAT/ARRL proposal to NASA Headquarters to obtain approval for Amateur Radio operation. Understandably, everything came to a halt in February 1986 when the Challenger accident caused the suspension of all Shuttle flights for several years.



John Nickel, WD5EEV, coordinating a SAREX contact with WA4SIR on his approach to Texas. (WB2D photo)

The SAREX Committee

When it became clear that Shuttle flights were to resume, work was started anew. By this time, a new committee had been formed by the ARRL Board of Directors to support and foster continuance of Amateur Radio operation on U.S. manned space missions. This group, chaired by Roy Neal, K6DUE, has since been dubbed the "SAREX Committee". AMSAT was asked to participate on the committee, and the author was named as the AMSAT representative. Since the establishment of the SAREX committee most of AMSAT's contributions to the Amateur manned space effort have been mainly channeled through the SAREX Committee. John Nickel, WD5EEV, was appointed to assist in getting through the maze of reports and other paperwork necessary to transact any business with the Government. John works at the Johnson Space Center but for Lockheed, one of JSC's principal contractors. Having him in this role has proved most valuable in getting the job done. The first order of business for the new group was to define what SAREX experiments were desired on the Astro 1 Mission, which, by then, had been designated STS-35. It was decided to include 2 meter FM voice and packet as well as the SSTV that had been proven so successful on STS-51F. In addition, it had been proposed to add a fast scan TV uplink experiment using 70 cm. The Committee's attention was rapidly turned to administrative matters when it was learned that, somehow during the hiatus following the Challenger accident, the approval for Amateur Radio's participation on the Astro I flight had fallen through a crack. This problem taken care of, hardware and software work was re-initiated. Many things had changed in the intervening two years. A suggestion was advanced that an antenna should be developed that could be located in one of the cockpit side windows, rather than aft-deck upper window as on the two previous flights. Such an antenna could be left in place for most of the mission, instead of having to be taken down whenever observations were to be conducted. The Motorola Amateur Radio Club at Schaumburg, Illinois volunteered to design and fabricate such an antenna usable for 2 meter voice, SSTV and packet as well as for the 70 cm ATV uplink experiment. In addition, new packet hardware had become available, principally a new very small TNC marketed by the Heath Company. AMSAT arranged for the donation of a sufficient number of these to support testing and flight requirements. It was determined that the Shuttle Payload General Support Computer (PGSC) could be made available, eliminating the need for a dedicated laptop to support the packet operation. New, smaller, more efficient power supplies became available. When it was determined by Lou McFadin, W5DID, principal JSC Amateur Radio Club coordinator for SAREX hardware, that such new power supplies were necessary to meet needs of the experiment, AMSAT requested monetary assistance amounting to $8,000 from ARRL. AMSAT's letter to ARRL President Larry Price led to a grant of that amount from the ARRL Foundation. Several additional hurdles remained, not the least of which was the revelation that, due to the length of the mission, locker space sufficient to store the full set of SAREX equipment would not be available. It looked for a while as if SAREX would be dropped from STS-35 altogether. But on a suggestion by Ron to

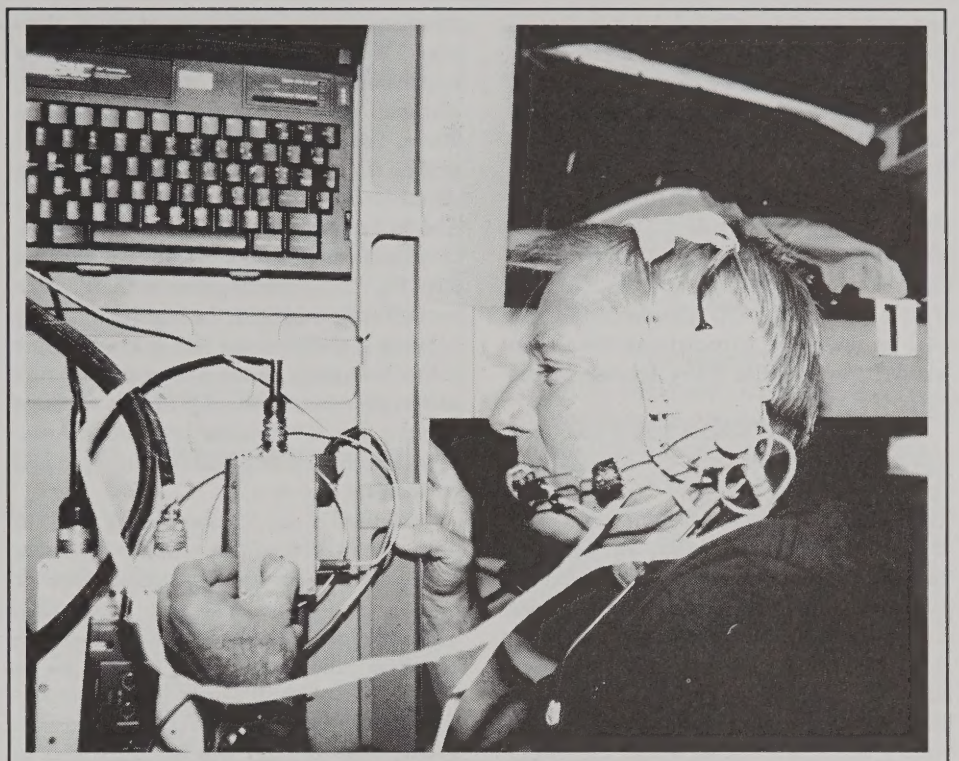
include only voice and packet capability, leaving SSTV and the fast scan TV uplink experiment to a later mission, things began to come together. As a result of having available the new smaller, more efficient power supplies and the Heath TNC as well as the promise of part time use of one of the PGSCs; Lou and his fellow JSCARC members were able to come up with a new small package that could be accommodated in the available locker space.

In the meantime, AMSAT was working on the software to support the various packet modes to be used. Tom Clark led the way by defining the requirements while the coding was put in the capable hands of Howard Goldstein, N2WX. Through his efforts, this code was written and tested in time to meet the STS-35 launch schedule.

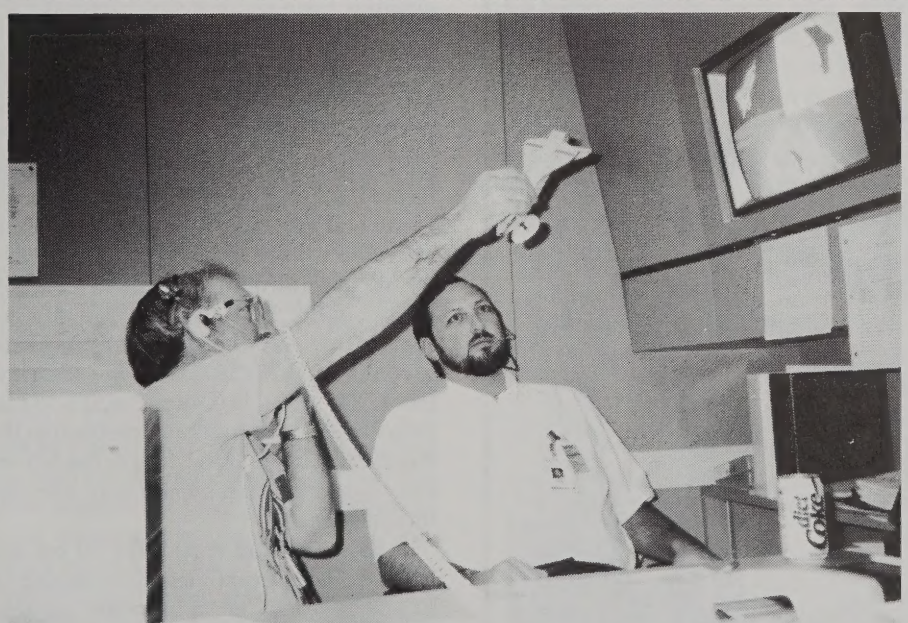
Increased Emphasis on Reaching Young People

AMSAT's other principal task in support of SAREX for STS-35 was in connection with the plan to allow school children across the country to talk with Ron during the mission. It was realized, early-on that, because of the night launch, the Shuttle would not be over the U.S. at appropriate times for school participation. In addition the low inclination of the orbit (28.5 degrees) meant that more northerly stations would have little or no chance to communicate directly. To circumvent these difficulties, Roy Neal proposed that a system of relays be set up involving Amateur stations in other parts of the world that would "patch" the children through to Ron as the Shuttle passed over the respective countries. AMSAT was asked to put this network together, including the selection and coordination of suitable stations. It was determined that three stations in Australia would provide nearly twenty minutes of coverage, whereas a single station could communicate with the Shuttle for somewhat less than ten minutes. AMSAT asked Graham Ratcliff, VK5AGR, to select and coordinate the Australian stations. Graham picked VK6IU in Western Australia and VK2AS in Sydney to assist him. To provide addition schedule periods, AMSAT enlisted the aid of Junior DeCastro, PY2BJO, in Brazil. Using these stations to affect communication between U.S. school children and WA4SIR required the establishment of overseas telephone communications to the participating stations as well as lines from the Amateur groups serving their local schools. In addition to selecting and coordinating the overseas stations, AMSAT's responsibility included establishing the telephone network to them as well as the network to connect to the various participating Amateur groups around the U.S. This task was accomplished through the donation of facilities, and excellent cooperation of the management and personnel of Darome Connection, a national supplier of teleconferencing facilities.

ARRL's Educational Activities Manager Rosalie White, WA1STO, assisted Ron in selecting some thirty out of the more than one hundred Amateur groups which had proposed to set up two-way conversations between Ron and school children in their areas. AMSAT people then entered these, along with the over one hundred remaining, into a computer data base and AMSAT volunteers assisted ARRL in informing the various groups as to the specific times each would be on as well as the procedures involved. This task was made particularly difficult on STS-35 because of the numerous



Astronaut Vance D. Brand, STS-35 Mission Commander, communicates with family members from the middeck of Space Shuttle Columbia in Earth orbit. The STS-35 SAREX system allowed Astro 1 crew members to "visit" with family members. (NASA photo)



Lou McFaddin, W5DID, demonstrates current orbiter attitude to Gary Morris, N5QWC, with the aid of a NASA software application shown on the video screen. The paper attachment to the model emulates the antenna pattern. (WB2D photo)

delays the mission suffered due to technical difficulties with the vehicle. Essentially, this scheduling had be done three times. Many AMSAT volunteers made numerous long distance phone calls before STS-35 blasted off on Dec 2nd, 1990.

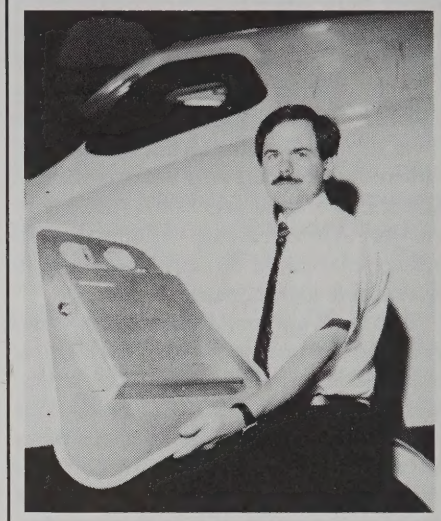
During the mission, AMSAT personnel, including its President Doug Loughmiller, KO5I, and the writer along with Roy Neal, Bill Everett, K7RIE, of Icom and Pete O'Dell, WB2D, of CQ Communications, were present at JSC to coordinate the eleven schedules with some thirty schools across the country.

Results of the school schedules were very favorable in terms of the interest generated among the children. However, the communication was not as fault-free as had been hoped. This was mainly attributed to the fact that SAREX must depend on an inside window-mounted antenna. Because of the pattern of this antenna and shielding by the vehicle, signal dropouts were more numerous than anyone would have liked. Effort is being initiated to attempt to get an outside antenna for some future flights beyond STS-37. See Ron's article in this issue for further details on the operation of SAREX during STS-35.

STS-37 — Next in the Series

Although some experiments had to be left out of STS-35 in order to retain any Amateur Radio participation in the mission, STS-37 is expected to make up for the missing pieces. It will employ 2 meter FM to affect two-way exchange of voice, slow scan TV and packet radio. In addition, an experiment to attempt one-way (Uplink) fast scan color television will be tried using 70 cm. The fact that FIVE licensed Amateurs will be aboard should facilitate scheduling Amateur operation. That's the good news. The bad news is that STS-37 is a relatively short mission (five days versus ten days for STS-35). The other negative is that, unlike most Shuttle missions, the highest intensity of work activity occurs late in the timeline rather than early. Since getting accustomed to the space environment generally requires about a day, it is unclear how much Amateur Radio operating will be accomplished on the first day or so.

Nevertheless, plans are being made to gain as much benefit as possible for Amateur Radio under the constraints that always exist on space missions. As on STS-51F and STS-35, emphasis will be placed on communication with young people. As on STS-35, a system of relays through designated Amateur stations, in conjunction with a telephone bridge, will be employed to obtain the greatest coverage—both in terms of length of the communication sessions and number of students participating. But, unlike STS-35, the STS-37 timeline calls for the Shuttle to be over the U.S. during the daylight hours so relay stations in this country can be used. Additional schedules can be supported by using certain South American stations, and effort is underway to make these available. It is planned to concentrate on holding two-way sessions with about a half dozen schools, rather than the thirty-some attempted on STS-35.



WA4SIR holds the SAREX antenna for STS-35. The antenna was built on a no-cost-to-the-government basis by the Motorola Amateur Radio Club in Schaumburg, IL. (NASA photo)

The slow scan television system will be used both with individual stations as well as with stations set up at schools. Despite the fact that the capability exists for two-way SSTV, emphasis will probably be placed on one-way transmissions from the Shuttle to ground stations. It is felt that young people will be more interested in seeing pictures sent to them from space in essentially real time, rather than sending theirs up.

The packet robot system, first tried on STS-35, will be used again, with some adjustments in an attempt to maximize the number of successful QSOs. Those trying to contact the SAREX packet robot should call only when the Shuttle in above the horizon. Send connect requests to KB5AWP (SSID=0). Those completely successful will receive a QSO number and disconnect. Many will get only the number minus the disconnect. They should retain the number for use in confirming the contact for a QSL following the flight. It is particularly important that everyone attempting any kind of contact with SAREX, keep deviation low (about 3 kHz.). It was found on STS-35 that Doppler shift can present a problem to the relatively narrow IF existing in the MX radio. Low deviation should help alleviate this problem.

As previously stated, the 70 cm fast scan television experiment to be carried on STS-37 is strictly an uplink-only proposition. The amount of Shuttle power available for SAREX is insufficient to provide usable downlink fast scan TV pictures. Even for uplink-only, the picture (no pun intended)

Astronomer Ron Parise, WA4SIR, sets up for a session at the SAREX station. (NASA photo)

Table I — Frequencies to be Used for Communication to and from SAREX or STS-37.

Voice & SSTV	*Shuttle to Earth (Downlink)*	*Earth to Shuttle (Uplink)*
	145.55 MHz	144.91 MHz 144.95* (600 kHz down) 144.97
Packet	145.51	144.91 (600 kHz down)
FSTV	None	436 MHz (A few selected stations)

* Primary Uplink Frequency. Others to be used at the discretion of the astronauts.

is quite bleak. It requires very high effective radiated power to achieve acceptable television pictures at the Shuttle. Therefore, a few selected stations are being assembled to try to achieve a successful demonstration of the feasibility, and value, of having TV reception available on manned spacecraft. It is believed that no standard TV has yet been sent to a manned spacecraft by either the Soviets or ourselves. See the accompanying article by Andy Bachler, N9AB, for more details of the FSTV uplink experiment.

Frequency Plan

The frequency plan shown in Table I is to be used for Amateur Radio operations on STS-37. Note that 144.95 MHz is the Primary voice uplink frequency. This is in line with having Earth stations use a different frequency than that being used by the Shuttle station, and maximizing the number of people who can manage split frequency operation by employing the same offset as repeaters do. However, the other listed frequencies may be used at the discretion of the astronaut Amateurs if they are experiencing too much QRM on the primary frequency. They will make an announcement when they are listening on other frequencies. REMEMBER — DO NOT TRANSMIT ON THE DOWNLINK AND TRANSMIT ONLY WHEN THE SHUTTLE IS IN RANGE OR NEARLY SO. Actually, it is best to transmit only when the downlink has been heard. Reports were received that some stations set their packet equipment up to transmit every minute, or even less, for the entire time that STS-35 was in orbit. Such practice merely causes QRM to terrestrial users and affords no advantage. The best way to know the location of the Shuttle is through the use of a tracking program run on a personal computer. Besides, it's fun and educational to see where the astronauts are in real time. AMSAT has available programs for most popular computers. Call 1-301-589-6062 for information. Also, keep track of the up-to-date schedule. (See Specific Schedules below.)

The STS-37 frequency plan is shown in Table I. Note that it is different from that used for STS-35, when the same frequency pair was used for both voice and packet. The change was made to reduce QRM and confusion, and should benefit both terrestrial users and the astronauts Amateurs.

Specific Schedules

It is difficult, weeks before an operation like this, to fully define all operations and impossible to predict last minute changes which might be necessary in those that are planned in advance. Therefore, it is most important that those who wish to participate keep informed on a near real-time basis. The best way to do this is to monitor the Amateur stations that are providing up-to-date information, including orbital data for use in computer tracking programs. Such stations include W1AW, WA3NAN, W5RRR, W6VIO and K6MF. Frequencies to be used by these stations are listed in Table II.

In addition, quick reaction newsletters such as the *ARRL Letter* and *OSR* can be expected to provide information current just prior to flight. Packet bulletin boards carrying AMSAT News Service, just prior to and during the flight, are also good sources of up-to-date information.

Beyond STS-37

With more and more astronauts becoming licensed, Amateurs, further SAREX missions are all but assured. A joint ARRL/AMSAT letter has just been sent to NASA headquarters requesting Amateur Radio operation on one or more upcoming high inclination orbits. Approval of this request will permit Amateurs in many parts of the U.S., Canada and Europe, who have been locked out by the 28.5 degree orbit used on most Shuttle missions, to communicate directly with the Shuttle astronauts.

The increasing number of astronaut Hams provides another potential benefit. Citing them as examples, we may be able to convince more young people to obtain Amateur licenses. The new code-free Technician License should assist in this process. ■

Table II — Frequencies to be used by Stations Providing Information for Amateur Radio Participation during STS-37.

Station	Approx QTH	Nominal Frequencies in MHz (+/- QRM)
W1AW	Hart. CT	Normal bulletin frequencies listed in *QST*
WA3NAN	Wash. DC	3.860, 7.185, 14.295, 21.395, 28.650, 147.45(FM)
W5RRR	Houston,TX	3.850, 7.227, 14.280, 21.350, 28.495, 146.64 (FM)
W6VIO	L.A. CA	14.270 (Japan), 21.340 (South Pac. 224.04 (FM)
W6FXN	L.A. CA	145.46 (FM)
K6MF	S.F. CA	3.840, 7.165, 145.58 (FM)

All are SSB using the sideband normally used on the band, except where otherwise indicated.

Shuttle Amateur Radio Experiment (SAREX)

This article is a draft of the official postflight report on the SAREX Mission as submitted to NASA by the crew of STS-35. The intended audience (NASA Management) has little or no knowledge of Amateur Radio. This results in some simplistic explanations on various aspects and concepts of the SAREX mission.

By Ron Parise, WA4SIR

Objectives

The primary objective in flying the SAREX experiment was to provide schools and other educational organizations, as well as other interested Amateur Radio operators with an opportunity to communicate directly with a Space Shuttle crew. This was to be accomplished via several different mechanisms. Educational organizations were encouraged to submit a proposal to the SAREX project requesting a two-way scheduled voice contact for their group. Approximately 860 such requests were received for the 38 available time slots which were identified in the SAREX timeline. These proposals were reviewed for originality in pre and post contact activities, number of students involved, suitability of proposed radio equipment configuration, and plans for media coverage. In addition to the 38 groups chosen for two-way contacts, 121 more groups were selected to be included in the SAREX ground support network on a listen only basis.

Since STS-35 was a night launch all passes over the continental U.S. occurred generally at night. This made it very inconvenient to schedule contacts with school groups while we actually passed over them. To alleviate this situation an elaborate network was established consisting of 3 ground stations in Australia and 1 in Brazil coupled with a teleconference bridge in Alexandria, VA. The purpose of this network was to allow us to communicate with the school groups during daylight hours in the continental U.S. while we were actually passing over other parts of the world.

A very popular communications mode today in Amateur Radio is called "packet radio". The name stems from the fact that it utilizes a packetized digital data communications protocol for error detection and correction very much like large commercial computer networks. The data however is transmitted back and forth between computers via radio instead of wires. To the user, packet radio is very much like dialing up telephone based computer bulletin boards, and is therefore ideally suited to unattended operation. A packet radio system was flown on STS-35 as part of the SAREX package to allow long periods of operation which would not be possible if crew attention was continually required. This mode (which was called the Robot mode due to its autonomous nature) allowed Amateur Radio stations on the ground to "connect" with SAREX and receive a personalized message back even when the crew was not available for operations. This mode also allowed a crew generated mission status message to be continually broadcast to interested stations on the ground.

Mission Results

Scheduled Contacts

Ground Station Relays

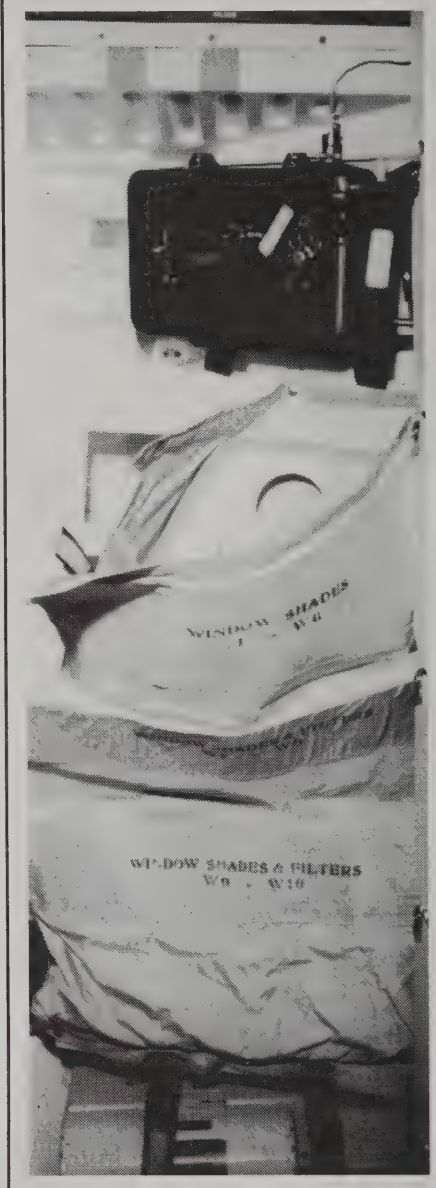
Of the 30 groups scheduled for contacts through the teleconference bridge 26 were successful. The groups who were not successful failed primarily due to unfavorable orbiter attitudes during their time slot. A plan is currently in work to communicate with the unsuccessful groups via ground based Amateur Radio stations and give them a chance to ask the questions which they had prepared for the crew.

Direct Contacts

In addition to the contacts through relay stations, 8 contacts were scheduled directly to the desired group. Six of these contacts were successful with orbiter attitude again being the primary cause of difficulty.

Robot Operation

The packet radio system was operated an average of 14 hrs per day. This period of time covered the 12hr red team duty day as well as those portions of the pre and post sleep periods which were not being used for scheduled contacts. The packet radio hardware maintains two logs in its own memory. One of these logs is a list of call signs of all of the stations which made complete contacts (A complete contact is defined as one in which an error free transmission is made in both directions with acknowledgements from the receiving station). The other log is a list of the call signs of the last 35 stations which were heard but did not necessarily complete their contact. By the end of the flight the list of complete contacts had grown to 238 stations in 16 countries. The heard log contains only the last 35 stations but it is broadcast in the downlink every 2 minutes allowing the stations on the ground to see whether or not they were heard by the orbiter. To reconstruct a complete log of all of the stations which were able to interact with the Robot we must depend on ground stations to mail



A closeup view of SAREX components on board STS-35. Inside the window shade stowage bag is the SAREX antenna. (NASA photo)

in copies of the downlinked log lists which they copied during the flight. At last count the total number of stations which were heard during the mission (including the above 238) was 620.

Unscheduled Voice Operation

During the later days of the mission it became possible to engage in a number of unscheduled random voice contacts with stations in various parts of the world. These areas included the Continental U.S., Hawaii, the Caribbean, Australia, Japan, and South Africa. Approximately 50 stations were contacted in this mode, however, the exact number will not be known until the log is constructed from the voice tapes.

Two-way Contact With Mir

One of the more exciting albeit secondary objectives for SAREX was to attempt a two-way voice contact with the crew of the Soviet space station Mir. The Soviets have carried Amateur Radio equipment on Mir for several years and have communicated with hundreds of stations on the ground. Since 1990 was the 15th anniversary of the Apollo-Soyuz Test Project, and the STS-35 commander was also the command module pilot for ASTP this could have been a very memorable event.

In order for this event to take place, the two spacecraft needed to pass within several hundred km of each other. The relative motions of the two ships brought us within 40 km of each other once every 8 days. The first of these opportunities occurred on MET day 2. Since the Soviets had launched their replacement crew only 2hrs after the STS-35 launch, MET day 2 was their rendezvous day and they were unavailable for a SAREX contact. The next opportunity was on MET day 10. Unfortunately, due to predictions of unfavorable weather at Edwards Air Force Base, STS-35 came home on day 9.

Equipment Performance

Antenna

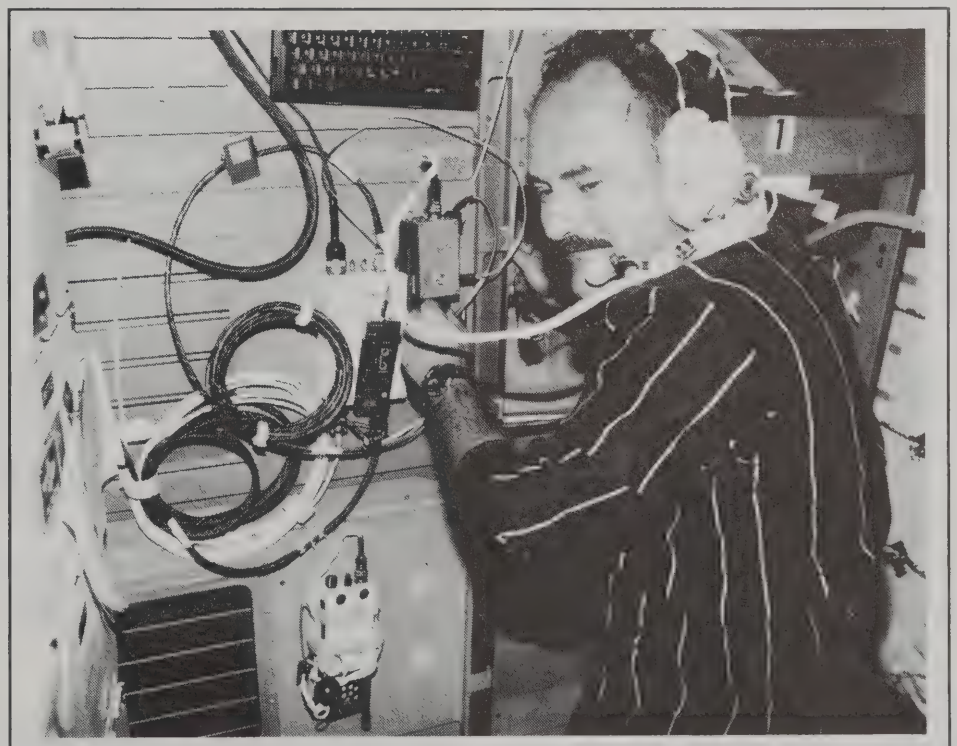
The antenna flown on STS-35 was designed to fit in the W1 or W6 windows. This is different than previous SAREX missions which used an antenna in the aft flight deck overhead windows. The change was made to minimize interference with Earth observation activities while the SAREX Robot was operating for long periods of time. The radiation pattern of the new antenna can be visualized as two coaxial cones with their axis perpendicular to the window in which the antenna was mounted. The projection of this pattern on the ground is then a circular to elliptical doughnut when the window is facing generally down (+or- Y/LV depending on whether W1 or W6 is in use). If the orbiter attitude is such that the plane of the window is approximately perpendicular to the ground (such as -Z/LV or + or - X/LV) then the ground coverage is a long rectangular strip parallel to the plane of the window. In the first case a deep null in signal strength is experienced when the orbiter is at its highest elevation over a ground station. In the second case only stations on the same side of the orbiter as the antenna will have acceptable communications. Based on these facts one might consider the W1 window statistically better for the antenna since the Ku Band antenna is on the other side and will be generally pointing away from the Earth. We began the mission with the antenna in the W6 window and subsequently changed to the W1 window on day 6 at the request of the SAREX support team in the CSR. It is not yet known whether this change produced a corresponding increase in success rate for the following contacts.

Transceiver

The radio which was used on STS-35 is a rugged Motorola VHF FM transceiver which is widely used in commercial applications. It is also the same one used on all previous SAREX flights. The transceiver performed flawlessly except for one problem. The bandwidth of the receiver in the radio is designed to just accommodate a standard narrow band FM signal (5kHz). This is to minimize adjacent channel interference in areas with crowded communications frequencies. Unfortunately in space communications the relative velocity between the spacecraft and ground station cause the transmitted signals to appear to drift in frequency due to the Doppler effect. This has the effect of shifting the received signal on board the orbiter partially out of the receivers passband which distorts the final audio output making it unintelligible. The Doppler shift is greatest at the beginning and end of a ground station pass, and a minimum when the spacecraft is directly overhead. The bottom line being that even with very strong signals, up to a minute at the beginning and end of a 10min pass are rendered unusable. There are two solutions to this problem (assuming the same transceiver is used). One is to require ground stations to reduce the bandwidth of their transmitted signal so that all of it will remain in the passband even when Doppler shifted. The other is to replace the filter in the transceiver with a slightly wider one thus accomplishing the same effect. The first suggestion was to have been implemented on STS-35 but most ground stations did not comply.

Terminal Node Controller (TNC)

The heart of the packet radio equipment is the TNC. This is basically a dedicated microprocessor that handles the details of the digital communications protocol with the ground stations and then communicates the resulting data to and from the host computer (in this case the PGSC). The TNC hardware worked very well



Mission Specialist John M. (Mike) Lounge gets his chance to "call home" from STS-35. (NASA photo)

throughout the flight. There are two comments that I would like to make with regard to the software within the TNC. The log which contained a list of the last 35 stations heard was too short. This buffer would fill up and be written over many times before the crew would have the opportunity to save it on the PGSC. I realize that this was due to memory constraints in the TNC. As a result of this we have been able to reconstruct only about a third of the total log so far and may never recover the entire list. The second comment is that in high traffic areas the TNC would become saturated and the broadcast messages (beacons) would no longer be downlinked on time. This may be unavoidable but it would be useful to revisit the relationships of the various timers and priorities which schedule downlink messages.

Payload General Support Computer (PGSC)

The PGSC performed well in the role as the SAREX host computer. The LCD screen was not very readable however and created some inconvenience. The tone generator was used by all of the SAREX software and produced alarms which were clearly audible on the middeck. In fact the software alarms were normally disabled so as not to disturb the sleeping blue shift crew members. All of the SAREX software and data files were kept on one high density 3.5" floppy disk. This was due to the current rule prohibiting experimenters from using the hard disk. This rule caused us to delete certain utility programs in order to leave sufficient disk space for the expected data files. Floppy disk access times are generally quite slow. The SAREX software team alleviated this problem by copying the entire floppy to a RAMdisk (a section of memory which is treated like a disk by the software) during the bootup and then operating completely from that. Updates to data files were always written to both the RAMdisk and the floppy disk to avoid loss of data should the computer crash or be inadvertently powered off.

Cables

The antenna feedline was of the proper length. It accommodated the antenna in either window without undue slack. The RS-232 cable (which is a standard PGSC accessory) was far too long. It was 25 ft. long while the PGSC was directly adjacent to the TNC to which it connected. The PGSC power cable was also 25 ft. long and was also connected to the TNC. The SAREX power cable was 25 ft. long which was acceptable since there are multiple outlets where power could have been obtained. The only cable which was too short was the one from the audio interface box to the microcassette recorder. I often operated from within the sleep stations due to concurrent treadmill activity and the microcassette recorder would just make it in the door. A 3 ft. cable would have been much better.

Recommendations For Future SAREX Flights

The scheduled contacts through relay stations were too tightly scheduled. We had three to four groups within each 15 min pass over Australia. Brief dropouts in communications caused whole groups to loose their opportunity which was very disappointing to them. Scheduling one or two per pass would be much better. The comm dropouts would only cause one group to miss part of their contact and would not disappoint several groups.

The design of the new window antenna should be revisited to see if the null in the response at the center of the pattern could be minimized. An antenna in the payload bay would be far superior to the window antenna. This may not be practical but should be investigated.

The receiver bandwidth should be increased to a value which would accommodate the Doppler shift of a standard narrow band FM signal as seen from low Earth orbit. This would eliminate the need to depend on ground based stations to reduce their bandwidth. Another solution is to qualify a more modern computer controllable transceiver so that the PGSC can continuously tune it to track the Doppler shifting signals.

Ask the PGSC folks to supply alternate length (6 ft.) cables for those users who do not require 25 ft. And lengthen the cable to the microcassette recorder to 3 ft.

Experimenters should be allowed to use the hard disk on the PGSC. We use many diverse software packages on our office PC's daily and rarely if ever experience problems of one program corrupting other program or data files. These kinds of problems are generally the result of hardware malfunctions and not software. A compromise solution might be to allow the experimenters to keep their programs on the hard disk but require them to keep data files on a floppy. This would provide much more data storage capacity on the floppy minimizing disk changing and would still protect the hard disk against erroneous writes from user programs. ■

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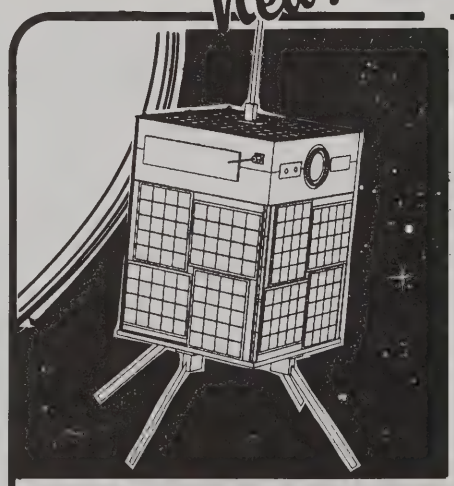

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AMSAT-NA OPERATIONS REPORT

There are so many things going on in Amateur satellite operation that it is difficult to keep track of them, much less mention them all briefly here. At the time of this writing, LUSAT has just begun BBS operations, meaning that all three orbiting PACSATs (UO-14, AO-16, and LO-19) are in full, public access operation. Combine this with the highly successful WEBERSAT mission that has been in full educational/experimental mode for most of a year, and the stage is finally set for intense DOVE development activity.

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SPAN: LOGOS::DUNCAN

DOVE

The reason DOVE has been saved for last is because, among the Microsats, it is the most different and the most tricky. Dangerous or fatal mistakes were to be made on the other three Microsats before the process of enabling all of DOVE's educational and popular features was begun. On AO-16, WO-18, and LO-19, a full crash or locked on transmitter is a serious matter, but not an insoluble problem. If DOVE's transmitter had been set to a lower power setting last spring when it got locked on accidentally, it would have been in electrical balance with the battery system and would have transmitted until satellite failure or significant solar cell degradation with little or no chance of recovery. As it was, it was running at the highest power setting and, after several days, the battery discharged, the power output went down (actually, it went off during some eclipse periods), and the anxiously sought hard reset was finally achieved. Not wanting to ever go through this again, the flight software development team decided to make their mistakes and gain as much knowledge as they could on the Microsats that were easier to recover before working seriously on DOVE. Barring another catastrophe, it won't be long now before DOVE is in service. Watch for packet bulletins interleaved with telemetry first, voice later.

NEW MISSIONS

Two new Soviet Amateur spacecraft have also been launched, RS-12/13 and AO-21/RM1. Up to now, neither had apparently entered regular service. In the case of RS-12/13, it was because the primary payload was being checked out. (Soviet Amateur transponders often ride on governmental or commercial satellite busses.) With AO-21, there was a commanding problem that was being studied carefully. As with most of the more complex payloads of the modern Amateur satellite era, some on orbit checkout is to be expected. With nearly every satellite since AO-10, it has taken a month to a year to attain full functionality in orbit. This is because checkout and after-launch development (software and ground equipment) are done by volunteers in their spare time. Ordinarily, these volunteers who don't have any spare time or "domestic tranquility chits" left during the early on-orbit days because of the effort they had to put forth to get a working box to the launch pad to start with. There are ways to improve on this situation in the future and AMSAT-NA departments, Operations among them, are moving in positive directions to that end.

Broader organizational involvement utilizing and managing more of the available talent is one of the answers. Having a bigger, better financed organization that could afford to hire some part or full time technical people would be another. AMSAT-NA Operations has greater involvement as a goal and is succeeding in involving many people in many interesting tasks and investigations. For the second goal, a better funding base is the goal of AMSAT-NA's General Manager Doug Loughmiller, KO5I, who also serves (in a volunteer capacity) as President.

LOTS OF SATELLITES

With all of the satellites we have available now (by my quick count, 18 of the 35 OSCAR and Radio Sputnik numbers ever used are still active now) there is hardly an hour of the day or night that doesn't contain an operational or monitoring opportunity for the motivated Amateur satellite operator. As AMSAT-NA Vice President for Operations, I feel overwhelmed some days (and my wife asks me if I don't ever get tired of sitting in that chair in front of the computer/radios!) just trying to keep apace of it all. Of course, as involved as I am, I can't do this all by myself. This is where programs like Command Station Development (CSDP), electronic mail (terrestrial and Amateur satellite based) and the Operations Net play an important role. Through each of these, people with a particular interest in one satellite, set of satellites, or facets of satellite operation are able to get together, exchange information, compare notes, and share with each other in the fun of all that is going on. Many of us have learned to, for instance, check into the net, report what we know, and enjoy vicariously the reports of others.

Some are experimenting with WEBERSAT L band uplinks, others are building S band receiving gear, others are exchanging files, programs, and messages via PACSATs, others are working on calibrating data for a certain telemetry set from certain satellites, some are writing programs to do all manner of support and utility functions for satellite operation, others are working DX, real time on AO-10 and 13 and non-real time on the PACSATs, some are rag chewing among multiple continents, and everybody is having a good time. The list of things to do, the choices and range of technical simplicity or difficulty is nearly endless today. This is a great time to be involved with Amateur satellites!

To date, several members of CSDP have completed the challenging Level-1 Certification program and are working on their Level-2 goals. As AMSAT has had the need, both before and after certification requirements are met, these operators are also tasked with various satellite monitoring, utilization, and maintenance responsibilities. If you're a team player and want to make a unique contribution, CSDP is the place to do it.

AO-16 PROVIDING GATEWAY SERVICE

Personally, I've spent much of my time for the last three months working directly with AO-16, uploading information and programs, setting up the broadcast rotation program, and working with the operational command team for various functions. This is all going very well, we have a talented and committed group to work with. The most exciting news for me is a connection that is now forming between AKNET (Alaska's packet BBS network) and the

packet network of the rest of the world. I noticed that John Lawson, NL7NC, in Anchorage was active on AO-16 and sent him a message inquiring about his procedures and setup. This developed rather quickly into a two way WØRLI style mail forwarding setup between NL7NC for AKNET and KI6QE in California for the "rest of the world" end. John informed me that, before AO-16, the connections between AKNET and the "lower 48" were tenuous at best. A long chain of HF stations in Canada were all subject to the anomalies of arctic propagation. Mail rarely got through and they hadn't seen AMSAT News in over a year! Now, not only is WØRLI style mail being passed back and forth several times per week, but AMSAT bulletins and other general interest Amateur Radio bulletins are being carried via PACSAT to Alaska and other places that have trouble picking them up too. The potential here is astounding. The PACSATs are beginning to serve their purpose. I hope to be reporting more on this and to hear from others in remote or "hard to get to on HF" places in the world for which PACSAT can provide the same sort of service.

Many of us are also beginning to think of solving the particular problems involved in automating the mail transfer and data collection process. Starting from a PACSAT station working with pg and pb, it's a small but challenging and important step to automatic operations. Problems to be solved include controlling all of those boxes involved from a computer, having computer programs (like tracking programs and protocol programs) talk to each other and help each other along, securing against unauthorized or accidental transmissions and equipment damage, and standards for exchanges and operations. This is an exciting, interesting, and meaningful time to be involved in these developments. One of the AMSAT Operations programs, be it nets, e-mail, CSDP, telemetry archiving, mail relaying, or whatever has a place for You! ■

AMSAT News

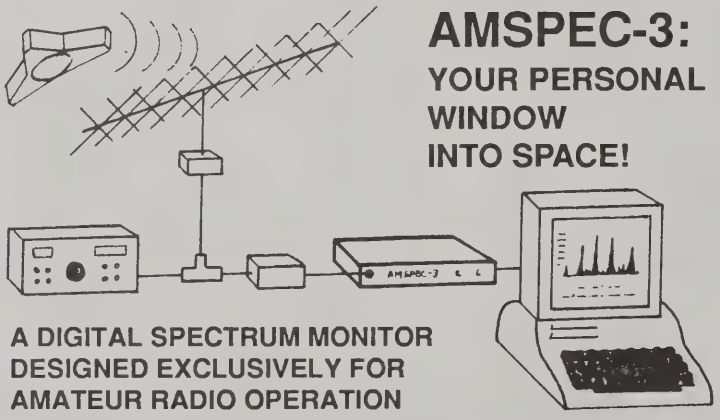
SIGNIFICANT DONATION OF SOFTWARE TO AMSAT

AMSAT has recently received the contribution of an important thermal analytic software package for use on our spacecraft development programs. The contribution of this software, called Thermal Analysis Work System, THAWS, was made on 7 February 1991 by Mr. Richard C. Turner, of Turner Associates Consultants, (TAC) to Dick Jansson, WD4FAB, of the Amsat Engineering Team.

The THAWS package operates on high level, 80386 processor PC computers, and is composed of two key software groups, NEVADA and SINDA. The NEVADA group of programs provide the most powerful and sophisticated thermal radiation computational routines available in the World. The usual method of radiative interchange computation assumes that all surfaces are rough and diffuse, even highly polished aluminum. With NEVADA, the analysis is done using Monte Carlo techniques and is not restricted to the glaring error of all surfaces being diffuse, as the program allows the use of real surface characteristics

The SINDA package is the thermal analyzer tool that is THE accepted software for thermal and fluid flow (and combined analyses) analytic computations. This program is really an operating system on itself, as its library is very extensive. Models generated for SINDA analysis on a PC can be sizable. (In 1990, I was doing a

(Continued on page 30)



AMSPEC-3:
YOUR PERSONAL WINDOW INTO SPACE!

A DIGITAL SPECTRUM MONITOR DESIGNED EXCLUSIVELY FOR AMATEUR RADIO OPERATION

You can **HEAR** the OSCAR satellites - now **SEE** the signals too! Not just another spectrum monitor, AMSPEC-3 by Mauro Engineering has advanced features you would expect only in a much higher priced instrument.
USE THE POWER OF YOUR PC OR COMMODORE 64 FOR DSP (Digital Signal Processing) to display those weak satellite signals. And the 70 dB dynamic range of AMSPEC-3 makes it a joy to use in strong adjacent signal environments.
THE UTILITY OF AMSPEC-3 DOESN'T END WITH SATELLITE USE - works great on HF and it's a natural for the test bench.
SPECIFICATIONS: ** frequency range 1.8 to 31.0 MHz - VHF/UHF coverage with receive converter ** sweep width 250 KHz in spectrum mode ** sweep rate 6 sweeps per second in direct mode - 3.5 seconds for one sweep in long signal averaging mode ** circuitry features dual conversion superhetrodyne design using double-balanced mixers ** sensitivity greater than 1 uV MDS ** 500 Hz resolution**
TO GET THE FULL STORY ON AMSPEC-3 send a business size SASE with two units postage. You'll receive a four page write-up with photos describing satellite use and minimal station requirements. Also included are all current application notes.
PRICE RANGE: PC and Compatibles - $279.00 ** Commodore 64 - $209.00
Plug-in power supply - $10.00 ** Splitters available
(Prices subject to change without notice - Calif. residents add sales tax)

RLD RESEARCH
McCloud CA 96057

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• Loop Yagis • Power Dividers •
Complete Arrays • GaAs FET Preamps
• TROPO • EME • Weak Signal • OSCAR •
Microwave Transverters
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2345 LYK45el 1296 MHz 20 dBi $89
1345 LYK45el 2304 MHz 20dBi $75
3333 LYK33el 902 MHz 18.5dBi $89
Above antennas kits available assembled.
Add $8 UPS s/h
Add $11 UPS s/h West of the Mississippi.

MICROWAVE LINEAR AMPLIFIERS SSB, ATV, REPEATER, OSCAR

2316 PA 1w in 18w out 1240-1300 MHz $265
2335 PA 10 in 35w out 1240-1300 MHz $315
3318 PA 1w in 20w out 900-930 MHz $265
3335 PA 10 in 40w out 900-930 MHz $320
23LNA preamp 0.7dB N.F. 1296 MHz $ 90
33LNA preamp 0.9dB N.F. 902 MHz $ 90

NEW PRODUCT ANNOUNCEMENTS

New Loop Yagis
1845 LY Loop Yagi 1691 MHz 20dBi $99
945 LY Loop Yagi 3456 MHz 20dBi $89
Above antennas assembled and tested

New Preamps
13LNA 0.7dB N.F. 12 dB 2.3 GHz $140
18LNA20 0.8dB N.F. 20 dB 1.69 GHz $140
SLNA 1.0dB N.F. 10 dB 2-2.7 GHz $150

New Wideband Power Amplifiers
2370 PA 3w in 70w out 1240-1300 MHz $695
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2318 PAM 1w in 18w out 1240-1300 MHz $205
Rack mount Amplifiers for repeater use available.

NO TUNE MICROWAVE LINEAR TRANSVERTERS
From SHF SYSTEMS a new line of transverters designed by
Rick Campbell KK7B and Jim Davey WA8NLC
Available in kit form or assembled/tested
• 903 1269 1296 2304 3456 MHz
• microstrip filters eliminate tune-up
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• sequencer standard in complete unit
• low profile packaging, mast mountable
All active equipment - 13.8V

DOWN EAST MICROWAVE
BILL OLSON, W3HQT
Box 2310, RR-1 Troy, ME 04987
(207) 948-3741

STS-37 Fast Scan Television Experiment

For the first time, a fast scan television (FSTV) experiment has been added to the SAREX package. The FSTV experiment is one way (uplink only) "real time" television transmission from a small group of selected ground stations to the shuttle orbiter. It is believed that this will be the first time that fast scan television is received by an orbiting manned spacecraft. If the experiment is successful, the use of FSTV can greatly enhance shuttle communications by supplementing audio with visual information.

By Andy Bachler, N9AB
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Unfortunately, transmission of visual information in real time requires a very large bandwidth. In this application normal NTSC color television standards are being used. This requires a bandwidth of approximately 6 MHz. As a result, two major problems have to be overcome; First, the television link between the shuttle and the ground stations is approximately 3000 times weaker (-35 dB) than the voice transmissions on two meters. This is due to the much larger receiver noise bandwidth and the necessity to use a higher frequency (70 cm). As a result, ground station requirements are much more stringent than for the normal "SAREX" participant. Second, the wide bandwidth (6 MHz) extends beyond the 435 - 438 MHz Amateur-Satellite Service subband. This is a problem because, any Amateur station communicating with a "space station" (any station more than 50 km above the surface of the Earth) is subject to the Amateur-Satellite Service rules and regulations. Each ground station selected for this experiment has been granted a special waiver from the FCC to allow the experimental television transmissions.

SPECIAL EQUIPMENT

Shuttle:

Reception of Amateur television in the orbiter requires a special television and antenna. The television is actually composed of two separate parts; (1) a video monitor/recorder which is also used for the SSTV (slow scan television) experiment and, (2) a special fast scan television receive module. The special antenna connection required for FSTV is already included in the SAREX window antenna, which flew on STS-35 in December 1990.

The FSTV receive module converts the 70 cm television signal into separate baseband video and audio signals, which are connected to the monitor/recorder. Functionally, the module consists of a bandpass filter, RF preamplifier, mixer and local oscillator, and IF amplifier which drives a small television IF module. Most of the conventional RF circuitry is contained in small hybrid modules which were designed for use in a Motorola hand-held portable radio. The IF module contains a video and sound IF integrated circuit and some associated filters, tuned circuits, and amplifiers. A circuit is included which detects the presence of video sync pulses and provides a control signal which, in the future, can be used to activate a recorder, indicator, etc. The components are mounted on a custom printed circuit board which was designed and fabricated by FAR Circuits in Dundee, Illinois.

The circuit board is housed in a 4"x 5"x 1" enclosure. The shuttle window antenna is a dual port annular slot antenna which includes filter circuits to provide isolation between the 2 meter and 70 cm connections. Reception of fast scan television using the 70 cm port can occur simultaneously with other SAREX activity using the 2 meter portion of the antenna. The antenna consists of a radiating element mounted on 2 inch stand-off insulators in a 14"x 14"x 2" open ended box. The box, in turn mounts to an aluminum plate which increases the size of the ground plane. The radiating element is a smaller 9 inch square plate. The larger aluminum plate is the same size and shape as the shuttle windowshades. In fact, the same rubber grommet material used on the window shades is attached to the perimeter of the plate to allow the entire antenna assembly to press fit into the window in the same fashion as the windowshades are installed. The larger plate is fabricated with a 13.44 inch square opening with eight symmetrical cutouts which form tabs. Eight stainless steel draw latches mounted inside the box hook over these tabs to securely position the box over the square opening in the plate. The symmetry of the design allows the box to be attached to either side of the plate which, in turn, can be pressed into either the commander's or pilot's side window. High antenna efficiency and minimal back radiation into the cabin results from this design. However, the close placement of the antenna to the window glass greatly affects the operating frequency of the antenna. An adjustment is built into the antenna to ensure optimum tuning each time the antenna is installed. A small reflected power coupler and an analog meter are also built into the antenna and connected to the 2 meter port to facilitate proper adjustment and monitoring.

Ground Stations

Each selected ground station is a high powered UHF combination satellite and ATV station. The satellite requirements include a computerized azimuth/elevation antenna tracking system. The ATV requirements include wide bandwidth capability and television experience and compatibility. To assure the best possible success, each ground station is striving to achieve the highest possible effective radiated power (within practical and regulatory limitations). In addition, antenna gain (which is inversely proportional to the antenna beamwidth) is limited by the ability to accurately track the spacecraft. Nevertheless, some stations will use an ERP approaching 1,000,000 Watts (90 dBm).

UNIQUE OPPORTUNITIES

As mentioned previously, Amateur Radio has a unique opportunity to demonstrate the capability of television transmission to a manned spacecraft. Subject matter is expected to include:

Live family transmissions to the crew,
Visual explanation of complex procedures,
Television links from students in a classroom,
Test messages.

One station, for example, is preparing a short video tape that shows space simulations by students. Over 36 schools in that one area are participating in the mock missions. The students are very excited, knowing that their activities may actually be seen by an orbiting astronaut.

EXPECTED RESULTS

Calculations predict reasonable to excellent results providing all parameters behave as expected. Various ATV trans-

(Continued on page 30)

AMSAT Regional Symposiums: A Beginners Guide and Model

The last few years have seen explosive growth in the technological development of Amateur satellite operational systems. There are currently no less than thirteen operational spacecraft, designed, built, and launched by 'professional Amateurs' who give their time freely for the advancement of the technology. Spacecraft systems that may be accessed through voice, CW, RTTY, fastscan TV, SSTV, packet radio, imaging, and telemetry downlinks are all available to the newcomer and expert alike. Presented here is a model for promoting the Satellite Program and AMSAT at the same time!

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VOICE: (214) 394-7325
and
Keith Pugh, W5IU
Regional Coordinator of Field Operations

While space-based and ground-based systems have evolved significantly over the past several years, the membership growth within AMSAT has not kept pace with the advancing technologies and functionality provided to the general Amateur population. This issue has its roots in the lack of active 'marketing' of AMSAT as a viable, dynamic organization which benefits its members and the Amateur Radio industry. If AMSAT is going to continue with evolutionary development efforts such as Phase 4 spacecraft, advanced imaging satellites, store and forward packet constellations, solar sail projects, etc., then we must, as an organization, expand our membership roles to help support and fund these complex undertakings.

AMSAT Field Operations has as one of its primary missions the recruitment of new members, Amateurs that add vitality, knowledge, enthusiasm, and a sense of mission' to the organization. AMSAT is a corporation, and like any other large corporation in this global market place of advanced technologies, we must market not only our products (satellites), but also market the benefits of belonging to AMSAT. This is a matter of getting out to the public and 'selling' AMSAT. Many Amateurs are aware that AMSAT has booths at the major hamfest (Dayton), and holds an annual symposium each fall in different geographic locations. This is not enough. We must constantly be out exposing the public to what the organization does, giving presentations, slide shows, showing videos of Amateur satellite launches, selling beginner's books, satellite tracking software, and most importantly, acting as mentors to the novice who has the interest, but not the know-how to get involved in this fascinating hobby.

Recent discussions by the Regional Coordinators of AMSAT, most notably Keith Pugh, W5IU, on how to increase AMSAT's visibility to the public, has led to the concept of smaller, 'regional' symposia, given at several locations across the country, or within a geographical region for AMSAT regional coordinators. These symposia will utilize multi-media presentations and real-time demonstrations as tools that will interest the public and drive membership growth within AMSAT. The first of these regional symposia and live demonstrations was held in Tyler, Texas on January 19-20, 1991. There were over sixty attendees and feedback from the audience indicated this was a resounding success, one that should be repeated several times a year within each geographic location served by the Regional Coordinators.

The idea of a "hands-on" Amateur satellite workshop in the North Texas area was

The Oscar antenna array that was driven down to Tyler from Irving, Texas on a trailer.

conceived by Bob Lobaugh, W5JYJ, of the Tyler, TX, Amateur Radio Club. Bob made his proposal to Doug Loughmiller, KO5I, and Keith Pugh, W5IU, at various hamfests in Texas over the past year. Doug agreed that AMSAT-NA would co-sponsor the event. The Tyler Amateur Radio Club made the arrangements with the Tyler Junior College for the meeting place and all arrangements for lodging, meals, etc. AMSAT-NA provided the program, station equipment, etc.

The program concept was to provide a series of beginners level classroom presentations supplemented by "live" demonstrations with the various Amateur and weather satellites. Following this activity, a dinner was planned as a break before an all night operating session through the "birds" from the workshop motel. The agenda that was held in Tyler is shown in the box to the right.

As can be seen, this is a fairly ambitious agenda; however, it came off with very few "hitches." The activities at Tyler Junior College were very well received by approximately 60 interested Hams and students. After a slightly delayed start caused by W5IU mis-setting the hotel room alarm clock, the station was set up just in time for a successful check-in to the AMSAT OPS net via AO-13. The workshop was "kicked off" by remarks from Bob Lobaugh who introduced Doug Loughmiller. After a few remarks, Doug showed an excellent new video tape on the history and status of the Amateur Radio Satellite Program. This new tape had been recently presented before the FCC to bring them up to speed on our activities. The program then proceeded on schedule with talks and live demos of UO-11 telemetry capture, DOVE telemetry capture, and an attempt at AO-16 operation. A "hitch" developed here in that the equipment and software used for the demo was being integrated on site for the first time. This attempt did not produce good results; however, the classroom presentation by Frank Perkins, WB5IPM, was well received and the demo was successfully accomplished during the lunch break on the next satellite pass. The afternoon activities proceeded without further "hitches" and were highlighted by the live NOAA-11 weather pictures (a real-time weather satellite station was setup by Jeff Wallach, N5ITU, of DRIG and copied both American and Soviet weather satellite imagery from 870 km in space. The audience was amazed that Amateurs (and AMSAT) had these advanced capabilities. RS-10/11 demonstrations were also conducted. During the RS-10/11 demo, contacts were made from the TJC demonstration station and from N5LKJ's mobile. We even made a contact "the hard way" between the demonstration station and N5LKJ's mobile. A de-briefing on the day's activities was held at the conclusion of the program. The consensus was that the activity was very beneficial and worthy of future scheduling of more events of this type.

TYLER AMATEUR SATELLITE WORKSHOP AGENDA
JANUARY 19-20, 1991

Saturday at Tyler Junior College

0800-0900	Arrival and Registration. AMSAT Ops Net on AO-13
0900-0915	Welcome and Introductory Remarks - Doug Loughmiller, KO5I, President of AMSAT-NA
0915-1015	Introduction to Amateur Radio Satellites - Keith Pugh, W5IU, AMSAT Regional Coordinator (UO-11 Pass 0937-0950)
1015-1030	Break
1030-1200	Working the Microsats - Frank Perkins, WB5IPM (DO-17 1049-1103, AO-16 1106-1120, LO-19 1129-1144, WO-18 1154-1208)
1200-1300	Lunch. Additional Microsat operations during lunch.
1300-1345	Satellite Tracking and Keplerian Data - Dick Campbell, N3FKV, AMSAT Orbital Data Manager
1345-1445	Weather Satellite Imaging - Jeff Wallach, N5ITU, Chairman of Dallas Remote Imaging Group, DRIG, and AMSAT VP of Field Ops. (NOAA-11 Pass 1355-1410)
1445-1500	Break
1500-1545	Shuttle Amateur Radio Experiment, SAREX, Past and Future - Bill Tynan, W3XO, AMSAT VP of Manned Missions
1545-1630	Poor Boy Satellite Station - Allan Fox IV, N5LKJ (RS-10/11 Pass 1555-1611)

Saturday at Sweet Sue's Family Restaurant

1830-2200	Dinner and Speaker - Doug Loughmiller, KO5I, President and General Manager of AMSAT-NA

Saturday and Sunday at Best Western Inn & Suite

2200-0920	"Work the Birds" -	
	Microsats	2200-0056
	RS-10/11	0154-0205 0335-0353 0524-0537
	FO-20	0411-0427 0558-0624 0749-0813
	Weather	All Night and into Morning
	AO-10	2257-0457
	AO-13	0339-0920
0920-until done	Tear Down and Head for home!	

Anyone that went hungry after the buffet dinner at "Sweet Sue's Family Restaurant" had only themselves to blame. Doug topped off the dinner with a few remarks about his travels on behalf of the Amateur Radio Satellite Program including attending a hamfest in the USSR this past

Some of the presenters setting up the operational Microsat/Weather Satellite ground station at Tyler Junior College (l to r: Dick Campbell, N3FKV; Allan Fox, N5LKJ; Doug Loughmiller, KO5I; and Jeff Wallach, N5ITU).

Dick Campbell at the operating station, waiting for an AO-16 pass and telemetry reception.

A very enthusiastic crew making their first Microsat contacts!

Summer.

After dinner, the station was installed at the motel and a few die-hards stayed up all night operating. Several folks, including Bob Lobaugh, made their first ever contacts through Amateur Radio Satellites. Others, such as the V.P. for Field Operations, managed to have dreams about operating through the satellites and slept until 7 A.M. the next morning. He did manage to finish breakfast and assist in loading the last of the equipment into Keith Pugh's car.

All in all, everyone had a good time. The logistics of this type of meeting are tough but the benefits are definitely worth it. Fortunately, the authors had their trusty AMSAT camera with them and took some photographs to document this very successful marketing and educational campaign.

It is hoped that this mini symposium format may be used as a template by other Regional and Area Coordinators of AMSAT to help drive the membership roles and bring new blood into the organization. A new videotape, " Amateur Satellites — At the Frontier" will be available from AMSAT Headquarters and is an excellent video presentation on AMSAT and Amateur satellites in general. Slide sets are being constructed to assist the AMSAT membership in giving high quality, professional presentations to the public at large.

With the advent of the Shuttle Amateur Radio Experiment (SAREX), the packet station on the USSR MIR space station (U2MIR-1), and voice communications on both, this is an excellent time to hold presentations at the local school districts and interest the budding student population with No-code licenses as an entree into the world of space communications.

These are indeed exciting times for AMSAT. Why not 'make it YOUR business' and provide the leadership and proactive marketing presence that will grow AMSAT membership throughout the 1990's and into the next century!

For further information on presentation materials, ideas on regional symposia, and how to market the AMSAT story, contact Jeff Wallach, N5ITU, at the address given at the beginning of this article. ■

Need a beginners guide for working OSCAR 13? See page 25 for details

Off the Pad

With Greatest Appreciation

An Editorial by AMSAT President Doug Loughmiller, KO5I

With this issue, we find ourselves passing the reigns of *The AMSAT Journal* from one steward to another.

After single handedly resurrecting *The AMSAT Journal* a little over two years ago, our friend and colleague Joe Kasser, G3ZCZ/W3 is stepping down as editor. Joe does so in order to enable himself to devote his time to other professional and personal pursuits including the completion of his work towards a Ph.D.

Joe's efforts on behalf of our organization have benefitted us all. As many of you are aware, Joe's volunteer efforts with AMSAT date back well over 15 years. His commitment to both quality and timeliness in producing the *Journal* is highly commendable and he deserves the thanks and appreciation of us all.

It is my hope that all AMSAT members will join me in extending a word of thanks to Joe for having performed a job well done at a time when his efforts were vitally needed. Thanks very much, Joe!

Taking over the reigns from Joe is another respected friend and colleague, well known to many long time AMSAT members, Drew Deskur, KA1M, a second generation AMSAT volunteer. His late father, Kaz, K2ZRO, was a stalwart AMSAT volunteer for many years during the early days of OSCAR.

Drew has been named AMSAT Vice President of Publications and will be serving as interim editor until a replacement for Joe can be identified and acclimated to their new responsibilities.

The fact that you have this edition of the *Journal* in your hands is proof that the transition from one steward to another has successfully taken place, as Drew has fully orchestrated the production of this issue with a helping hand from Bob Myers, W1XT, John Champa, K8OCL, the authors of the individual articles and many others.

While, as I stated, we will be bringing a new editor on-board shortly, Drew will retain overall responsibility for *Journal* production. I know that he would be pleased to hear from you if you have any thoughts or ideas about the *Journal*, including any submissions you might wish to offer. Please join me in welcoming Drew to his new position. Until next time, 73 and enjoy! ■

SATELLITE TRACKING MADE EASY

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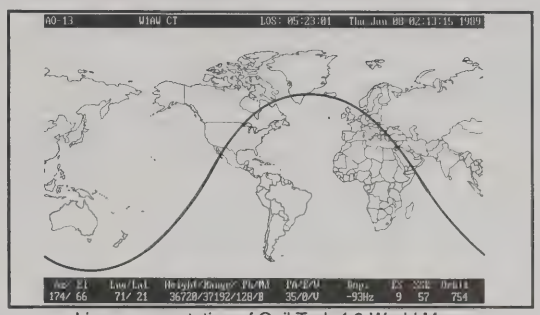

Line representation of QuikTrak 4.0 World Map

QuikTrak 4.0

Whether you want to identify the next time Oscar 13 will provide communications between two cities or if you just want to know the next time you can visually sight the Soviet space station MIR, QuikTrak will let you plug in the latest Keplerian elements for up to 100 satellites using a new full screen editor. QuikTrak also supports autotracking. *Hardware requirements*, IBM PC, AT, PS/2, or clone with a minimum 512K memory. CGA or EGA graphics required. Numeric coprocessor not required but recommended.

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These are only a few of the features of QuikTrak and InstantTrack. The figures below reflect suggested donations to defray production expenses and benefit AMSAT's non-profit, educational activities.

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Membership Software Survey

Have you ever wished you had a program for your computer that could do a particular job in connection with your satellite activities? Have you wished for an enhancement to an existing program? Well, here's your chance to tell us about it. The questionnaire to the right is your place to let us know what you need. We suggest you photocopy it (not cut it out of your magazine!) and send it completed to the address indicated.

By Roy D. Welch, WØSL
AMSAT Software Exchange Manager
908 Dutch Mill Drive
Manchester, MO 63011-3548

The questionnaire presented with this issue is for the purpose of making a survey to determine just what our membership needs and capabilities are in the area of software usage and development. We need to know what your priorities are so that we can point the efforts of volunteers in those directions.

We also need serious software developers who can be depended upon to take a few skeleton ideas, enhance them, add some of their own and go to work with little direction. That's how most of our existing software came about. People like you, who wanted to make their computers do all those neat things they needed, sat down and went to work to make it happen. That's what we need, people who can just make it happen.

It can be fun putting all those bells and whistles together and quite rewarding to receive letters from satisfied (almost) users giving you those "wouldn't it be nice to have..." enhancement comments. Be forewarned however. It's addictive.

We need your input. Please take the time to complete the survey and send it to me at the address on the survey. The results will be published in a future issue of *The Journal.* ■

SURVEY
AMSAT SOFTWARE LIBRARY

COMPUTER: IBM-PC Compatible____ Macintosh____ APPLE II____
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Tandy Color____ TRS-80____ Atari____ Sinclair____
Other_____

VIDEO GRAPHICS (Yes/No)?____
If yes, what type? CGA___ EGA___ VGA___ Hercules___
Other_____

SOFTWARE YOU ARE PRESENTLY USING (Name & Version Number):
Tracking_____
Telemetry Decoding_____
PACSAT BBS_____
Other_____

SOFTWARE YOU WOULD LIKE TO SEE DEVELOPED FOR THE ABOVE COMPUTER:
Tracking____ Telemetry Decoding____ PACSAT BBS___
Other(describe features)_____

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ARE YOU WILLING TO REPRODUCE SOFTWARE FOR THE AMSAT HEADQUARTERS OFFICE (Yes/No)?____

OTHER COMMENTS/THOUGHTS?_____

Please complete and mail to: Roy D. Welch, WØSL,
908 Dutch Mill Dr., Manchester, MO 63011

Software Fix

There is a bug in ORBITS II and ORBITS III Version 4.01 which will prevent AutoUpdating of Keplerian Elements from a NASA format input file when the day

(Continued on page 30)

RADIO-M1/RUDAK-2

Talk about International Cooperation. This article is a joint effort between an Englishman, a German and a Russian, and is being published in the USA.

By Peter Guelzow, DB2OS
Joe Kasser, W3/G3ZCZ
11421 Fairoak Drive
Silver Spring, Md. 20902
and Leo Labutin, UA3CR

Introduction

Almost a year after the launch of the Microsats and Fuji-OSCAR 20, the next Orbiting Satellite Carrying Amateur Radio (OSCAR) has finally begun its journey into space. Launched on January 29, 1991, RM-1 is the first international OSCAR in which Radio Amateurs from the Soviet Union took part. The original launch was planned for January 1990, but the launch was delayed several times (June, November, early January 1991) and was finally launched from the Soviet Launch facility in Plesetsk

RM1 stands for "RADIO M-1", which is the official name of the project. The digital transponder RUDAK-2 is part of RM1. After a successful launch this satellite was renamed as AMSAT-OSCAR 21, to emphasize that the spacecraft was built by, and for, Radio Amateurs around the world.

Background

The idea of a joint effort between the two groups, one in the USSR and the second, in Germany first appeared in the spring 1989. The discussions about what and how things had to be done continued until the meeting of the representatives of the two groups in Surrey in July 1989 when the preliminary agreement about the cooperation was signed. The final version of the cooperation agreement was later signed in the autumn of 1989 after much of the work had been completed.

According to the mutual agreement, AMSAT-U-Orbita developed and made the linear transponder, command radio link, telemetry system and power supply system. The ground command station was developed by the AMSAT-U-Orbita and AMSAT-U-Sputnik groups. They also acted as liaison to the government organizations regarding any issues surrounding the location of the equipment and launch.

The RUDAK group of AMSAT-DL developed and built the digital sub-system, called RUDAK-2, which contains a digipeater and an AX.25 mailbox. It also provides other possibilities for experiments in transmitting of information using modern digital methods. It also contains its own RF input and output circuits. The RUDAK group also provided some special digital sections for the command station.

During the launch and orbital test period ground, the command stations will be situated in Molodechno at UC1CWA and in Moscow at RK3KP. The ground command stations for RUDAK-2 will be situated near Munich at DK1YQ and near Hannover, at DB2OS.

The final agreement was signed on behalf of AMSAT-U-Orbita by the technical director of project "RADIO-M1" - V.Chepyzhenko, RC2CA; and on behalf of AMSAT-DL, by their president, K. Meinzer, DJ4ZC. The Project Manager for the RUDAK-2 is Hanspeter Kuhlen, DK1YQ. The coordinators for the project are P. Guelzow, DB2OS and L.Labutin, UA3CR.

The Mission

RM-1 was attached secondary payload (Piggy-back) aboard a USSR geological research satellite. RM-1 will provide a Mode B communications transponder in low Earth orbit. RM-1 will also provide an orbiting experimental digital communications capacity.

The Launch and Orbit

The Launch occurred on 29 January 1991 from the North Cosmodrome at Plesetsk. The orbit is a slightly elliptical polar orbit with an appogee of 1000 km at an inclination of 83 degrees. The period of the orbit is 105 minutes.

Specifications of the Satellite

Dimension and shape: Cylinder of height about 4 meters and diameter 1.8 meters.

Table 1 — Primary Payload

```
Beacons and telemetry #1
        CW telemetry 8 channels          145.822 MHz   0.2 Watts
        Digital telemetry 30 channels    145.952 MHz   0.4 Watts
                                         1100 bps,BPSK/FM, deviation 2kHz
        Digital telemetry Rudak-2        145.983 MHz   3.0 Watts
                                         BPSK 1200 bps AX.25 (like FO-20)
Transponders #1

        Linear transponder:          Inversely heterodyned translator
        Uplink passband              435.102 to 435.022 MHz
        Downlink passband            145.852 to 145.932 MHz
        Transmitter output max       10 Watts
        Bandwith  (3dB)              80 kHz
        Uplink EIRP required about   100 Watts

    (2) Digital transponder Rudak-2: digipeater and store & forward
        packet communication (AX.25), telecommunications experiment
        with digital signal processing up to nearly  20 kHz,
        1 MByte RAM disc, four separate uplink channels.

        Uplink frequencies: RX-1  435.016 MHz 1200bps,FSK,NRZIC/Biphase-M
                            RX-2  435.155 MHz (AFC) 2400 bps,BPSK, Biphase-S
                            RX-3a 435.193 MHz (AFC) 4800 bps,RSM
                            RX-3b 435.193 MHz (AFC) 9600 bps,RSM
                            RX-4  435.041 MHz (digital AFC) RX for RTX-DSP

        Downlink frequency:       145.983 MHz     3 Watts

        The downlink can be switched to the following operating modes:
        Mode 1: 1200 bps, BPSK, NRZI,(NRZ-S) (like FO-20)
        Mode 2:  400 bps, BPSK, Biphase-S (Like AO-13 beacon)
        Mode 3: 2400 bps, BPSK, Biphase-S
        Mode 4: 4800 bps, RSM, NRZIC (Biphase-M) (like 4800 bps uplink)
        Mode 5: 9600 bps, RSM, NRZI (NRZ-S) +Scrambler (like 9600 bps uplink)
        Mode 6: CW keying (only for special events)
        Mode 7: FSK (F1 or F2B),e.g. RTTY, SSTV, FAX, etc.(for special events)
        Mode 8: FM modulated by D/A signals from DSP-RISC processor (speech)
```

Table 2 — Secondary Payload

```
Beacons and telemetry #2
CW telemetry 8 channels          145.948 MHz   0.2 Watts
Digital telemetry 30 channels    145.838 MHz   0.4 Watts
                                 1100 bps,BPSK/FM, deviation 2kHz
Digital telemetry 30 channels    145.800 MHz   2.0 Watts
                                 1100 bps BPSK/FM, deviation 2kHz

Transponder #2

Linear transponder: inversely heterodined translator
Uplink passband              435.123 to 435.043 MHz
Downlink frequencys          145.866 to 145.946 MHz
Transmitter output max       10 Watt max.
Bandwith  (3db)              80 kHz
Uplink EIRP required about   100 Watts
```

System configuration:

Professional geological research equipment, telemetry system, command link equipment, transponders and power supply, thermal control, Amateur linear and digital transponders, telemetry system, command link equipment, power supply.

Attitude control:

Satellite attitude will be maintained using a gravity gradient approach in the form of a rod 9 meters long pointing away from the Earth.

Planned service life:

3 years.

Radio-M1/RUDAK-2 System Specifications

System configuration:

Two sets of the equipment will be installed aboard the satellite: Linear transponder #1 is Mode B and contains the RUDAK-2 and other subsystems, while Linear transponder #2 Mode B with subsystems. The Primary transponder is Linear Transponder #1, the second one is a spare which can be put into operation in the event of a failure of the primary system. Mode B in low Earth orbit provides a very good communications link as anyone who worked AMSAT-OSCAR 7 Mode B will testify.

Transponder and Beacon Data :

The Transponder RF Frequency Assignments and Beacon Data for the Primary Payload are shown in Table 1, those of the backup system in Table 2. The 1100 bps is not a misprint, it is real. Apparently this data rate is used by a popular PC tape cassette interface in the Soviet Union. Because this PC is simple and cheap for the Hams in the USSR, the AMSAT-U-Orbita team decided to use it on this spacecraft, much in a similar manner to the use of reversed AFSK tones in UoSAT-OSCAR 11 due to the wide availability of a popular interface for those tones in the United Kingdom. *Editor's Note: For the time being, there is no equipment presently available (in the West) to decode the 1100 bps beacon. However, the next generation "all singing, all dancing" DSP boxes that are soon to be available could very well have the software written for this beacon in the near future.*

Antennas

The 435 MHz receiving antenna which is shared by the analog and digital modes is a Helix with up to +3 dB gain using Right Hand Circular Polarization. The 145 MHz transmitting antenna is a half wave dipole.

Power System

RM-1 draws up to 100 Watts from the main spacecraft's power supply system. The Primary RM-1 payload including the RUDAK draw up to 47 Watts, the secondary payload draws up to 40 Watts.

Weight and Size

The Primary RM-1 payload including the RUDAK weighs approximately 28 kg, the secondary payload weighs approximately 22 kg. Both payloads are about 480 x 400 x 300 mm^3.

The Telemetry

Radio-M1 transmits Morse code (CW) and digital telemetry.

The CW telemetry will start up as soon as the bird separates from the launch vehicle and the Radio-M1 equipment will be powered by main satellite power system. A CW Morse-Code telemetry frame consists of the call RS14 and 8 channels of four digits in the following format:

```
RS14 S0AB
     S1AB
     S2AB
     S3AB
     S4AB
     S5AB
     S6AB
     S7AB
```

Channels 0 to 6 contain analog telemetry data. Channel 7 contains engineering calibration parameters. The first digit (S) identifies which system the telemetry is from. A prefix of 6 identifies a general status, a prefix of 2 identifies a command status. The second digit (0 to 7) are the numbers of the line (channel). The remaining digits (A and B) are the analog telemetry data which can be decoded according to the equations shown in Table 3.

For example, a typical frame and its meaning are shown below.

```
RS14
6080   - 4 Watts     - general
6137   - 37 Deg. C   - general
6224   - 24 Volts    - general
6316   - 16 Volts    - general
6409   - 9 Volts     - general
2524   - 24 Volts    - command
2632   - 32 Deg. C   - command
2700   - 0           - command
```

Digital Telemetry (preliminary)

The preliminary digital telemetry from RM-1 are as shown below:

The Digital telemetry consists of 30 parameters monitoring on-board conditions and 2 calibration verification points.

Table 3 — CW Telemetry decoding parameters

Channel (line)	Parameter	Formula	Unit
0	Transponder power output	0.05N	Watt
1	Transponder PA Temperature	N	Deg. C
2	+24 V Regulated	N	Volt
3	+16 V Regulated	N	Volt
4	+9 V Regulated	N	Volt
5	+24 V Regulated	N	Volt
6	Inside Temperature	N	Deg. C
7	Engineering Value	N	*

Table 4 — Decoding Equations for RM-1 Digital Telemetry (Version 26-Dec-90)

Line	Parameter	Formula	Unit	Hex-Format-Line
1	"Zero" of the comparator	0C		0000
2	Reference voltage	6D		0010
3	Transponder #1 HF ouptut pwr	0.2N^2	Watt	0020
4	Transponder #1 PA temperature	0.8*N	deg. C	0030
5	DC/DC converter temperature	0.8*N	deg. C	0040
6	+14 V Regulated	10*N	Volt	0050
7	+24 V Regulated	10*N	Voll	0060
8	+16 V Regulated	10*N	Volt	0070
9	+12 V Regulated	10*N	Volt	0080
10	+9 V Regulated	10*N	Volt	0090
11	+7.5 V Regulated	10*N	Volt	00A0
12	+5 V Regulated	10*N	Volt	00B0
13	+9 V Regulated (linear)	10*N	Volt	00C0
14	+9 V Regulated (digital)	10*N	Volt	00D0
15	Service	N	*	00E0
16	Service	N	*	00F0
17	Transponder #2 HF output pwr	0.2*N^2	Watt	0100
18	Transponder #2 PA temperature	0.8*N	deg. C	0110
19	+24 V Regulated	10*N	Volt	0120
20	+16 V Regulated	10*N	Volt	0130
21	+10 V Regulated	10*N	Volt	0140
22	+9 V Regulated	10*N	Volt	0150
23	+7.5 V Regulated	10*N	Volt	0160
24	Status command link 1	*	*	0170
25	Status command link 2	*	*	0180
26	Status command link	*	*	0190
27	Status command link	*	*	01A0
28	RPC +5V for Rudak-1	2.47*N	Volt	01B0
29	RPC +5V for Rudak-RTX	2.47*N	Volt	01C0
30	RPC +5V for Ramdisk	2.47*N	Volt	01D0
31	RPC +14V total supply current	627-289*N	mA	01E0
32	RPC module temperature	56.7*N-49.5	deg. C	01F0

Note: RPC - Rudak Power Conditioner. The Service and command link channels are reserved for use by the ground control team.

If you intend to receive, decode and display the digital telemetry you will need an FM receiver, a TNC, a PSK modem, and a computer or terminal. The decoding equations for the digital telemetry are shown in Table 4.

The format of the digital telemetry on your screen is as shown in Table 5.

Summary

RM-1 is an interesting spacecraft, and will provide a basic platform for communications experiments. If you can't work Mode B, then if you have a PK-87/88/232, a PSK demodulator and a 2m receiver you can at least get a peek at the telemetry it is sending back. ■

Table 5

```
0000 0C E6 0C E6 0C E6 0C E6 0C E6 0C E6 0C E6 0C E6
0010 6D E6 6D E6 6D E6 6D E6 6D E6 6D E6 6D E6 6D E6
0020 i  E6 i  E6 i  E6 i  E6 i  E6 i  E6 i  E6 i  E6
.....................................................

01F0 j  E6 j  E6 j  E6 j  E6 j  E6 j  E6 j  E6 j  E6


i...j -  the value of the parameter in the hex format, repeated 8 times

E6 - separation 0010 6D E6 6D E6 6D E6 6D E6 6D E6 6D E6 6D E6 6D E6
     0020 i  E6 i  E6 i  E6  E6 - separation
```


AMSAT Headquarters has the Satellite Operating Software you need. For a complete list, see the *AMSAT Journal*, July, 1990, page 14 and this issue page 28.

A Beginners Guide to OSCAR 13, by Keith Berglund, WB5ZDP, is a step-by-step guide to getting started on OSCAR 13. $7 in the U.S., $8 in Canada and Mexico, $10 elsewhere.

The Satellite Experimenter's Handbook, by Dr. Marty Davidoff, K2UBC, is the finest book written for the Radio Amateur. $22 in the U.S., $25 in Canada, $30 in South America and Europe, and $35 elsewhere.

Satellite Anthology is the best of recent *QST* articles on Amateur Satellite Operation and hardware. $8 in the U.S., $9 Canada, $10 elsewhere.

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Amateur Satellite Communications and the SEDS AMSEP Project - Part I

The second flight of the Small Expendable-Tether Deployer System, (SEDS) will be flown as a secondary payload on a Delta II 7925 launch vehicle, now scheduled for launch in the middle of 1993. The SEDS package will be attached to the exterior electronics bay wall on the second stage of the Delta II. It is proposed that a Student Experiment Package (SEP) carrying AMSAT Mode A and J linear transponders along with two student experiments be flown as a replacement for a planned 50 pound dead weight. The SEP and the AMSAT transponders, (AMSEP) will be deployed on a 20 or 40 kilometer tether attached at the other end to the Delta II second stage. The Marshall Space Flight Center Amateur Radio Club is integrating the SEP as well as providing expertise and oversight to the project.
This paper describes the SEDS, the SEP with experiments, and the proposed AMSAT transponders. Also AMSEP flight operations and the required Amateur Radio support for acquiring and recording the flight data is described. The need for AMSAT support is also discussed.

By Dennis Wingo
The University of Alabama in Huntsville SEDS

Ed Stluka, W4QAU
Marshal Amateur Radio Club
MARC

Chris Rupp, W4HIY
Marshall Amateur Radio Club
MARC

This paper in part is a revisit of the paper delivered at the AMSAT Symposium last year in Des Moines, IA by Chris and Ed. Our proposed mission will be the second flight of the SEDS system, the first being a downward deployment of the tether with the end mass being deorbited by the forces involved in a downward deployment of a tethered system. The first end mass is being built by NASA Langley. Due to the desire of the NASA Tether Dynamics Working Group (TDWG) for an expanded data set of information for the dynamics of tether deployment, the UAH Students for the Exploration and Development of Space, (UAH SEDS) is proposing a new SEP mission with the result being that the SEP will be placed into a permanent orbit after the tether dynamics mission objectives have been met.

The SEDS 2 flight objectives are to demonstrate that the tether can be fully deployed away from the Earth without stopping prematurely, that it can come to a smooth stop on application of a brake, and that over time, the tether and SEP can assume a stable gravity gradient attitude relative to the Earth. NASA data will be down linked over a Delta II S-band telemetry channel. The student experiment's data will be down linked over the AMSAT Mode J transponder. At the end of the tether mission the satellite ownership and operational control will be turned over to AMSAT/NA for use as an OSCAR, serving the AMSAT community which demands the availability of a OSCAR 8 type satellite. This will provide easy to use transponders for those Amateur Radio operators new to satellite communications. The SEDS was originally planned to deploy a 50 pound dead weight end mass on a 20 km tether. Chris Rupp, W4HIY, the Treasurer of the MARC and the lead engineer on SEDS asked Ed Stluka, W4QAU, secretary of MARC to consider putting a payload of student ex-

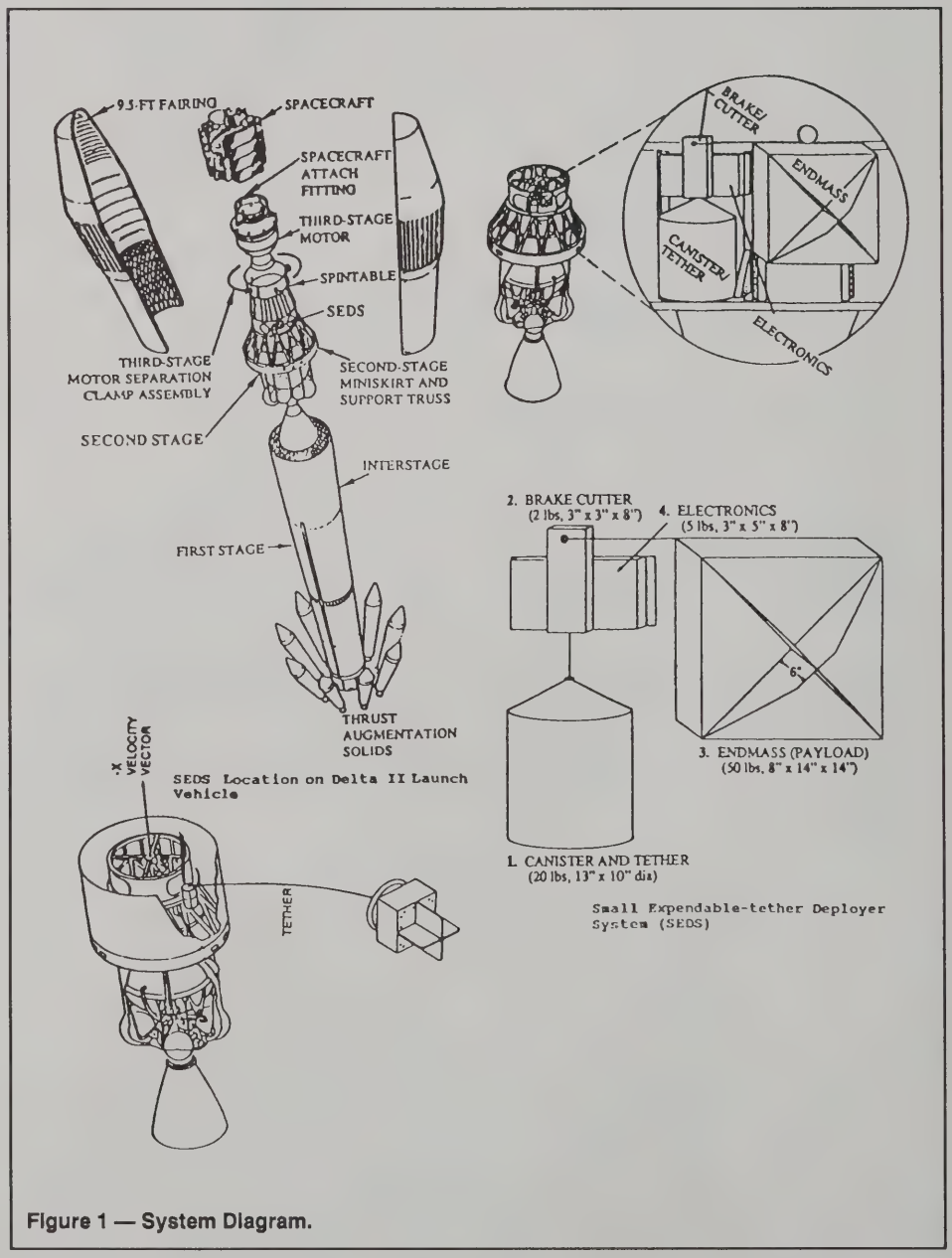

Figure 1 — System Diagram.

periments in the end mass instead of the dead weight. UAH SEDS led by Dennis Wingo, (former WB4KSF) agreed to submit experiments and design and build the SEP package. SEDS also agreed to raise the necessary funding for a Microsat class satellite. Dr. S. T. Wu, Director of the Center for Space Plasma and Aeronomic Research, (CSPAR) at UAH, agreed to provide administrative support to the project. Dr. John Champa, K8OCL, Executive Vice President of AMSAT-NA is working with the Detroit Oscar Users Group, (DOUG). DOUG has agreed to lead the effort to provide the AMSAT Mode A/J transponder pair.

Approach

As of this writing most of the funding has been secured from national and international sources. In addition, support in the form of technology sharing is being sought from AMSAT, and technology sharing and technical support memorandum of understanding is being worked out between UAH SEDS and Weber State Center for Aerospace Technology, (CAST). These agreements are being sought out in order to maintain as much compatibility as possible with the current Microsat software technology. This also shortens the development time associated with the project. This is crucial considering that the launch date is assumed to be April-May 1993. Many conversations have been devoted to settling the issue of uplink and downlink frequencies. DOUG has recommended the Mode A/J combination as the one most desired by a large number of the Amateur Radio satellite community. UAH SEDS, has agreed to provide funding for the start up of the AMSAT cleanroom in Dearborn, MI with the conclusion of a general agreement with AMSAT on participation on this project.

Locally, much volunteer support has been forthcoming from local NASA and industry personnel to support the student effort both with expertise and facilities. The expertise will be used in an advisor/teacher role to give the students first hand knowledge in working in the "real world" of design. UAH SEDS in addition to funding, has a six hundred square foot laboratory dedicated to space flight projects such as this one. CAD/CAM terminals from Intergraph are available and will be used to generate most of the detailed drawings for the project. PC based thermal analysis software worth over ten thousand dollars has been donated to the engineering school by Thompson Associates of Incline Village, Nevada. This software consists of SINDA, NEVADA, and SSPTA. These are the same packages as were used to model the Microsat. This resource is also available to us. The camera for our mission is being constructed in Taiwan by students at the National Cheng Kung University (CKU). This is part of a program of cooperation already in place for our Shuttle Get Away Special Program.

Legal and administrative support and oversight is being provided by Dr. S. T. Wu, of CSPAR and the University's Research Administration Department. Student class credit for participation in this project is available through the departments of Electrical, Mechanical, and Aerospace Engineering. It is planned that this project becomes part of an ongoing program of "hands on" engineering to improve the skills of the graduating engineer at our University. This is perhaps the most important aspect of this project.

Too much is said about improving education and too little is being done. AMSAT cooperation, and participation with universities such as UAH, University of Surrey, and Weber State College is beneficial to all concerned in improving technology and engineering skills in the experimental world.

Small Expendable-Tether Deployer System (SEDS)

SEDS is managed by the Marshall Space Flight Center in Huntsville, AL. The Tether Applications Co, San Diego CA is the mechanical systems contractor. The Marshall Space Flight Center, (MSFC) is responsible for the electronics systems associated with the deployer. Subcontractors to Tether Applications are McDonnell Douglas for Delta II interface studies; Teledyne Brown Engineering for engineering analysis and documentation; and the University of California in San Diego for fabrication of the SEDS structure. Figure 1 shows the location of SEDS on the Delta II, the AMSEP deployment from the Delta II second stage and the major assemblies of the SEDS and AMSEP.

SAREX T-SHIRTS

BACK

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Mission Operations Concept

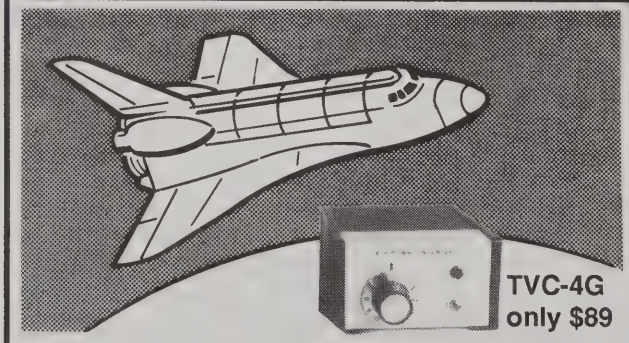
SEDS will be activated by a sequencer command from the Delta II telemetry system after the primary payload has been deployed. Via either preprogrammed or ground control, the Delta II second stage will restart and place the stage and SEDS package in an orbit that will be circular at an altitude of between one thousand and fifteen hundred nautical miles. After this orbit is reached the stage will exhaust its fuel in a depletion burn that will gain about one degree of inclination. The final inclination will be approximately thirty five degrees. The envisioned orbital altitude will result in a RF footprint for the AMSEP of between three thousand and thirty seven hundred miles in diameter. This along with the inclination of the orbit will provide satellite communications over almost all populated areas of the Earth.

AMSEP deployment will begin on command from the SEDS Data System. This command will fire pyrotechnic charges, releasing the Marmon clamp. Spring ejection will impart a velocity of 1.5 meters/second to the satellite. This deployment will begin over the west coast of the United States to allow overlapping coverage by dedicated student ground stations at the University of New Mexico, Mississippi State University and UAH. Also this will provide U.S. based Amateur Radio satellite operators the opportunity to participate in the deployment real time telemetry capture. Software will be provided at cost through the AMSAT software exchange to allow the graphical viewing of the tether experiment data on PC's or MacIntosh computers.

The deployment phase will last between 5800 to 7800 seconds, (96 to 130 minutes) depending on the tether length used. Experiment data will be down linked in real time as well as stored onboard for later playback. During the deployment, the tether position is about 50 degrees below vertical. The polyethylene synthetic fiber tether, (SPECTRA-1000) unwinds from a stationary aluminum core, feeds through a friction brake assembly, a cutter, and is finally attached to the payload. A stepper-motor operated by the SEDS data system applies the brake that controls the tether tension during payout and thus the tether deployment speed. Full deployment is reached at 5100 seconds, (20 km tether) followed by a 50 degree swing upward to the nadir that is completed at 5800 seconds. Since the tether is not cut at this time as in the SEDS 1 mission, the tether and AMSEP will oscillate in a pendulum fashion for an undetermined amount of time until finally stabilized into a vertical gravity gradient mode. The student experiments will operate until the tether is broken by natural forces. If this has not occurred in six months the tether can be severed at the AMSEP end by embedded resistive heaters. Six months is considered the maximum duration of the Long Duration Tether Dynamics Experiment (LDTDE). At tether separation, the AMSEP will gain altitude equal to seven times the length of the tether. This gain in altitude will constitute the apogee of the final satellite orbit.

The SEDS Data System onboard the second stage will be the primary downlink for information desired by NASA. The system will record, store, and continuously downlink over the Delta II S-Band telemetry data channel to the ground. It will count the turns as the tether unwinds from the core and control the tether brake. It also serves as an event timer and responds to sequencer commands from the Delta II telemetry system. Other data stored will include tether tension, temperature, and supply voltage. The Delta II downlink capacity ranges from 1kbit/sec to 115 kbit/sec. This telemetry is completely separate from the Amateur Radio portion of the mission and will be supported by NASA and Air Force ground stations.

AMATEUR TELEVISION



SEE THE SPACE SHUTTLE VIDEO

Many ATV repeaters and individuals are retransmitting Space Shuttle Video & Audio from their TVRO's tuned to Satcom F2-R transponder 13. If it is being done in your area on 70 CM, all you need is one of our TVC-4G ATV 420-450 MHz downconverters, add any TV set to ch 3 and 70 CM antenna. Others may be retransmitting weather radar during significant storms. Once you get bitten by the ATV bug - and you will after seeing your first picture - show your shack with the TX70-1A companion ATV transmitter for only $279. It enables you to send back video from your camcorder, VCR or TV camera. ATV repeaters are springing up all over - check page 411 in the 90-91 ARRL Repeater Directory. Call for a copy of our complete 70, 33 & 23 CM ATV catalog.

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P.C. ELECTRONICS Tom (W6ORG) Maryann (WB6YSS)
2522 S. Paxson Ln Arcadia CA 91007

Present software items available from AMSAT:

```
1.  IBM-PC & Compatibles
      Tracking   - INSTANT TRACK        EGA/VGA graphics
                 - QUIKTRAK 4.0         CGA/EGA graphics
                 - ORBITS II            CGA graphics
                 - ORBITS III           EGA/VGA graphics
                 - QUIKTRAK FOR IBM     no graphics
      Telemetry  - TLMDC, WHAT's UP, LO19DEC, PACBRO, etc.
                     (all on one diskette)
                 - AO-13 PSK
      Pacsat BBS - PG/PB
      Other      - Weberware            for picture displays

2.  Commodore C-64
      Tracking   - SUPERTRAC            graphics

3.  Commodore C-128
      Tracking   - ORBITS               no graphics

4.  Macintosh
      Tracking   - SATELLITE HELPER     graphics
      Telemetry  - (FO-20 program pending)

5.  Apple II
      Tracking   - APPLE QUIKTRAK       graphics

6.  Amiga
      Tracking   - ORBITS               no graphics

7.  Tandy Color Computer
      Tracking   - C-TRACK 1            no graphics
                 - C-TRACK 2            graphics

8.  Atari ST
      Tracking   - SATELLITE PREDICTION PROGRAM
                   with graphics
                   (This is pending evaluation)

8.  Hewlett-Packard Calculator
      Tracking   - SATELLITE ORBITS 2 with time module
                 - SATELLITE ORBITS 1 no time module

9.  Others (TRS-80, SINCLAIR, etc.)
      None currently available through AMSAT
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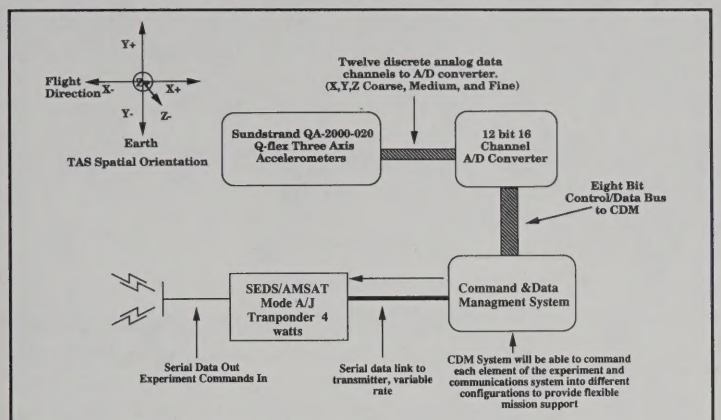
Y+
Flight Direction
X-
X+
Y-
Z-
Earth
TAS Spatial Orientation
Twelve discrete analog data channels to A/D converter. (X,Y,Z Coarse, Medium, and Fine)
Sundstrand QA-2000-020 Q-flex Three Axis Accelerometers
12 bit 16 Channel A/D Converter
Eight Bit Control/Data Bus to CDM
SEDS/AMSAT Mode A/J Tranponder 4 watts
Command &Data Managment System
Serial Data Out Experiment Commands In
Serial data link to transmitter, variable rate
CDM System will be able to command each element of the experiment and communications system into different configurations to provide flexible mission support

Figure 2 — Functional block diagram for TAS.

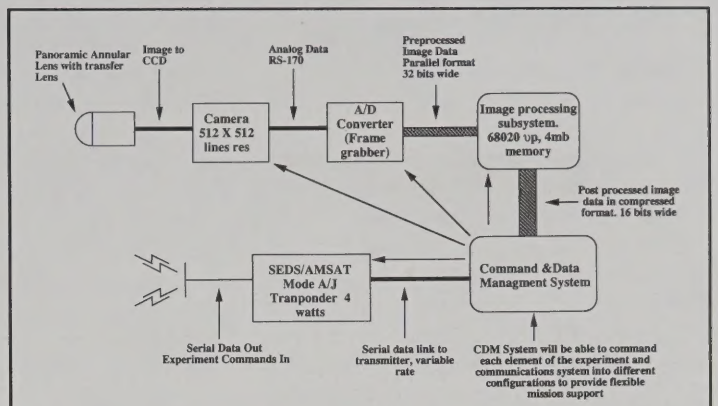
Panoramic Annular Lens with transfer Lens
Image to CCD
Analog Data RS-170
Preprocessed Image Data Parallel format 32 bits wide
Camera 512 X 512 lines res
A/D Converter (Frame grabber)
Image processing subsystem. 68020 up, 4mb memory
Post processed image data in compressed format. 16 bits wide
SEDS/AMSAT Mode A/J Tranponder 4 watts
Command &Data Managment System
Serial Data Out Experiment Commands In
Serial data link to transmitter, variable rate
CDM System will be able to command each element of the experiment and communications system into different configurations to provide flexible mission support

Figure 3 — Functional block diagram for SEASIS.

Student Experiment Package

The student experiment package consists of two co-operating experiments designed to support the gathering of tether dynamics information. A third student experiment will be mounted on the second stage itself.

Three-Axis Accelerometer System (TAS)

The objective of TAS is to obtain angular and linear acceleration data in three levels of g, (10-1, 10-2, and 10-4). Each accelerometer also has a temperature output for determining temperature compensation for the accelerometer outputs. This totals twelve analog outputs that will be fed into a dedicated high accuracy 12 bit A/D converter. Figure 2 is the functional block diagram for TAS. The experiment requires +/- 15 VDC at 150 mA and weighs 1.5 pounds. The hardware design has already flown on sounding rockets and is a mature design. The accelerometers are QA 2000-020 from Sundstrand Corp, Redmond, Washington. This same unit is used for the inertial guidance of the NASA Mars Observer spacecraft.

SEDS Earth Atmospheric and Space Imaging System (SEASIS)

The SEASIS experiment uses a unique Panoramic Annular Lens (PAL) to enable the experimenters to decouple the angular accelerations of the AMSEP due to spring deployment from the linear and angular accelerations induced by the tether as it deploys from the second stage. Figure 3 illustrates how this will be accomplished. The PAL is a single element lens with spherical surfaces which forms an internal virtual image of its surroundings. The image information is mapped, using stretching methods, onto a flat surface creating a 2-D representation of the 3-D cylindrical surface, and is transferred by a collector lens to a sensor array. The depth of field of the PAL extends from the surface of the lens out to infinity.

In the SEASIS experiment, a Charged Coupled Device (CCD) camera is used to electronically resolve images, and gathers and amplifies light in a 700 X 400 pixel array. An electronic automatic iris control is used to limit the lighting level when viewing bright objects. A mechanical iris may also be used to supplement the electrical one. The camera collects an image and produces an analog signal. A flash analog to digital converter/frame grabber is used to convert the camera's analog output to a digital pixel array where each element is one byte in length. The board is software and hardware agile, allowing the sample rate, data array size, analog data channel, data phase, and trigger source to be controlled by computer. The hardware and software driver for this frame grabber will be provided by Weber State. A dedicated 68020 microprocessor is used as a compression engine to transfer the data from the frame grabber to image memory where the data is compressed by software into a compact form. After compression, the data is transferred via DMA through a 16 bit data port to the satellite Command Data System (CDS). Software for the display of the images will be part of the software package made available to the AMSAT community.

The final part of this article will be presented in a subsequent issue of the AMSAT Journal. *This article originally appeared in* The 1990 AMSAT Symposium Proceedings. ■

Satellite Orbital Elements

March 9, 1991

```
AO-10
1 14129U 83 58  B 91063.34532753 -.00000104  00000-0  99999-4 0  6398
2 14129  25.8586 157.5216 5994082 222.1074  71.7788  2.05883481 30094
UO-11
1 14781U 84 21  B 91066.57946127  .00004043  00000-0  73905-3 0  9335
2 14781  97.9100 115.1085 0012931 128.2226 232.0137 14.66370080374556
RS-10/11
1 18129U 87 54  A 91066.99504260  .00000143  00000-0  14517-3 0  5469
2 18129  82.9275 133.6389 0013436 106.0941 254.1652 13.72155056185719
AO-13
1 19216U 88 51  B 91053.11378759 -.00000126  00000-0  99999-4 0  2396
2 19216  56.8252 109.0878 7128019 247.8593  26.4295  2.09703733 20619
UO-14
1 20437U 90  5  B 91066.70027352  .00001243  00000-0  50772-3 0  3132
2 20437  98.6782 146.7594 0011503 100.3726 259.8778 14.28944740 58498
AO-16
1 20439U 90  5  D 91066.53161066  .00001255  00000-0  51139-3 0  2057
2 20439  98.6791 146.8522 0012456 104.8369 255.4190 14.29038721 58474
DO-17
1 20440U 90  5  E 91064.34711593  .00001348  00000-0  54732-3 0  2046
2 20440  98.6797 144.7136 0012294 111.0461 249.2082 14.29101445 58164
WO-18
1 20441U 90  5  F 91063.97084201  .00001177  00000-0  47913-3 0  2036
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RS-12/13
1 21089U 91  7  A 91064.35259476  .00000256  00000-0  26172-3 0   230
2 21089  82.9246 181.0556 0028182 207.5518 152.4150 13.73865053  3886
```

STS-37 Television

(Continued from page 17)

missions from high altitude balloons provided data, from line of sight paths of over 250 miles, which support our expectations for the experiment. The biggest concerns include spacecraft orientation and interference from other stations. Since the antenna produces a pattern similar to a 1/4 wave ground plane, definite nulls in the pattern exist. In addition, blockage from a large portion of the spacecraft can be expected. Fortunately, data concerning the antenna pattern and spacecraft orientation was obtained from STS-35 and the crew is using this information as they select their SAREX opportunities. Interference to Amateur television is nearly always a concern due to the large required bandwidth. In the television signal passband there exists a tremendous amount of room for additional signals. To help alleviate this problem, the FSTV receive module contains a front end bandpass filter to help eliminate out-of-band interference. Hopefully, in band signals (which may include repeater links, remote control auxiliary stations, simplex FM, satellite users, repeater inputs, etc.) will cooperate with the ATV experiment. The potential certainly exists for several minutes of snow free color television during each of the attempts. ■

Receive Only	Freq. Range (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	Device Type	Price
P28VD	28-30	<1.1	15	0	DGFET	$29.95
P50VD	50-54	<1.3	15	0	DGFET	$29.95
P50VDG	50-54	<0.5	24	+12	GaAsFET	$79.95
P144VD	144-148	<1.5	15	0	DGFET	$29.95
P144VDA	144-148	<1.0	15	0	DGFET	$37.95
P144VDG	144-148	<0.5	24	+12	GaAsFET	$79.95
P220VD	220-225	<1.8	15	0	DGFET	$29.95
P220VDA	220-225	<1.2	15	0	DGFET	$37.95
P220VDG	220-225	<0.5	20	+12	GaAsFET	$79.95
P432VD	420-450	<1.8	15	−20	Bipolar	$32.95
P432VDA	420-450	<1.1	17	−20	Bipolar	$49.95
P432VDG	420-450	<0.5	16	+12	GaAsFET	$79.95
Inline (rf switched)						
SP28VD	28-30	<1.2	15	0	DGFET	$59.95
SP50VD	50-54	<1.4	15	0	DGFET	$59.95
SP50VDG	50-54	<0.55	24	+12	GaAsFET	$109.95
SP144VD	144-148	<1.6	15	0	DGFET	$59.95
SP144VDA	144-148	<1.1	15	0	DGFET	$67.95
SP144VDG	144-148	<0.55	24	+12	GaAsFET	$109.95
SP220VD	220-225	<1.9	15	0	DGFET	$59.95
SP220VDA	220-225	<1.3	15	0	DGFET	$67.95
SP220VDG	220-225	<0.55	20	+12	GaAsFET	$109.95
SP432VD	420-450	<1.9	15	−20	Bipolar	$62.95
SP432VDA	420-450	<1.2	17	−20	Bipolar	$79.95
SP432VDG	420-450	<0.55	16	+12	GaAsFET	$109.95

Every preamplifier is precision aligned on ARR's Hewlett Packard HP8970A/HP346A state-of-the-art noise figure meter. RX only preamplifiers are for receive applications only. Inline preamplifiers are rf switched (for use with transceivers) and handle 25 watts transmitter power. Mount inline preamplifiers between transceiver and power amplifier for high power applications. Other amateur, commercial and special preamplifiers available in the 1-1000 MHz range. Please include $2 shipping in U.S. and Canada. Connecticut residents add 7-½% sales tax. C.O.D. orders add $2. Air mail to foreign countries add 10%. Order your ARR Rx only or inline preamplifier today and start hearing like never before!

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Software Fix

(Continued from page 22)

value is less than 100. This bug only showed up after the first of the year when the NASA EPOCH value began to have a blank in the hundreds position of the day number. The updates from an AMSAT format file are not affected. This is because the AMSAT EPOCH format has no blanks embedded in it. For example the AMSAT format would be 91012.345678 while the equivalent NASA format would be 91 23.45678. This is a sneaky one isn't it! Version 4.01 copies shipped after 2-7-91 already have this fix included.

Roy Welch, WØSL, will provide a correction update to users who return their original diskette to him at 908 Dutch Mill Dr., Manchester, MO 63011. ■

AMSAT NEWS

(Continued from page 16)

spacecraft model analysis that was easily 1000+ Nodes and the data deck consisted of more than 420,000 Bytes of ASCII code. A ten orbit computation of this model required 2 hr 20 minutes of 80386-33 PC time.)

Both the SINDA and NEVADA group of software are compiled with 32 bit operating systems, rather than the more common 8 bit PC operations. AMSAT wishes to express its deepest gratitude to Richard C. Turner and Turner Associates Consultants for their generous contribution. The value of this donation by Turner is more than $10,000, and is considered to be a high-water in industry support for AMSAT. — *Dick Jansson, WD4FAB*

AMSAT Board of Directors Nominations

Nominations are sought for the AMSAT Board of Directors. Directors are elected by the membership for a two-year term. Any member society or group of five current members can nominate a member to run for the position.

This year there are four seats to be filled. Those directors whose seats are up for election are Jan King, W3GEY, Andy MacAllister, WA5ZIB, Bob McGwier, N4HY and Bill Tynan, W3XO.

All nominations should be sent to: AMSAT BOD Nominations, 850 Sligo Ave. #600, Silver Spring, MD 20910. They should arrive no later than June 15, 1991. ■

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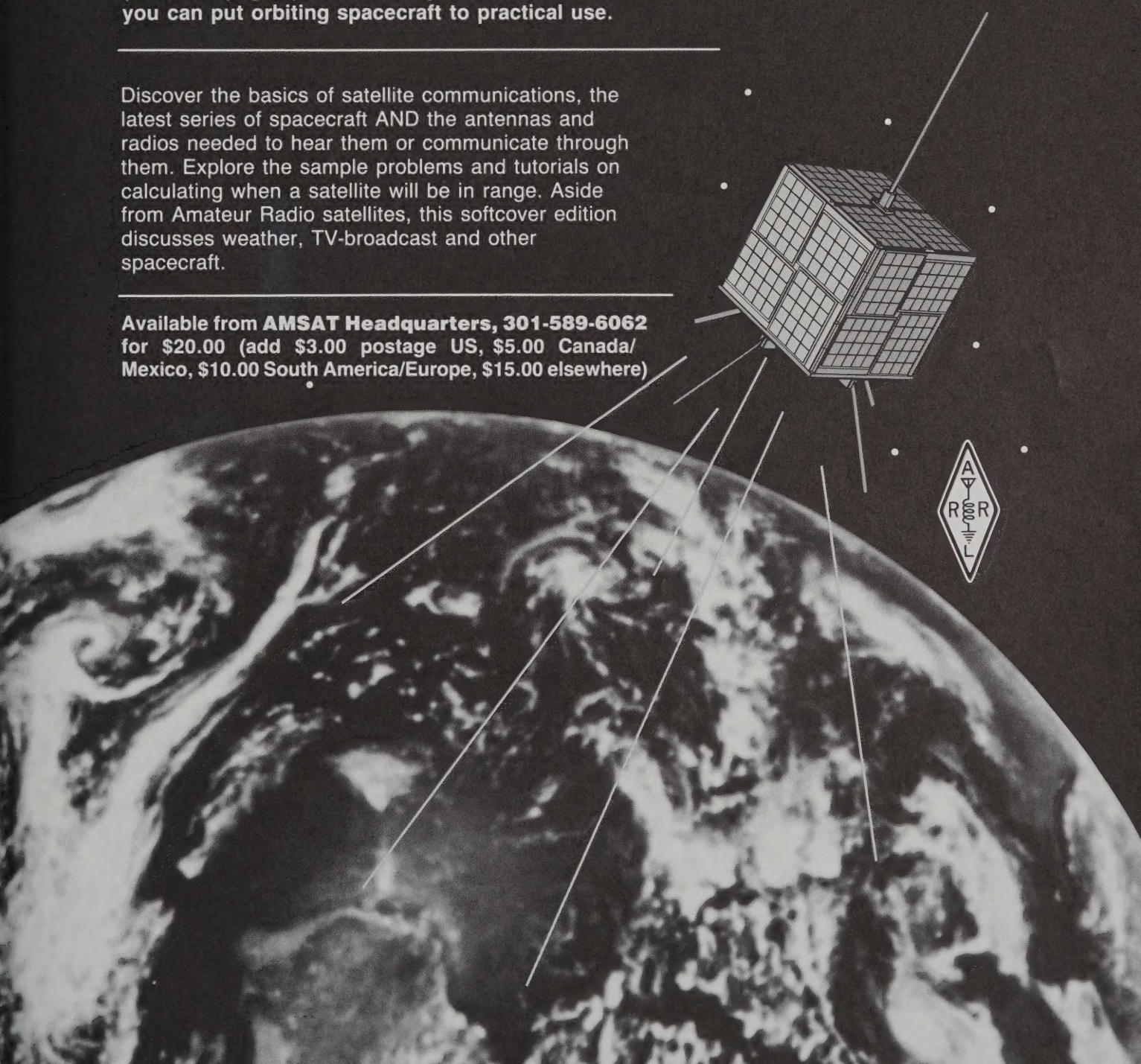
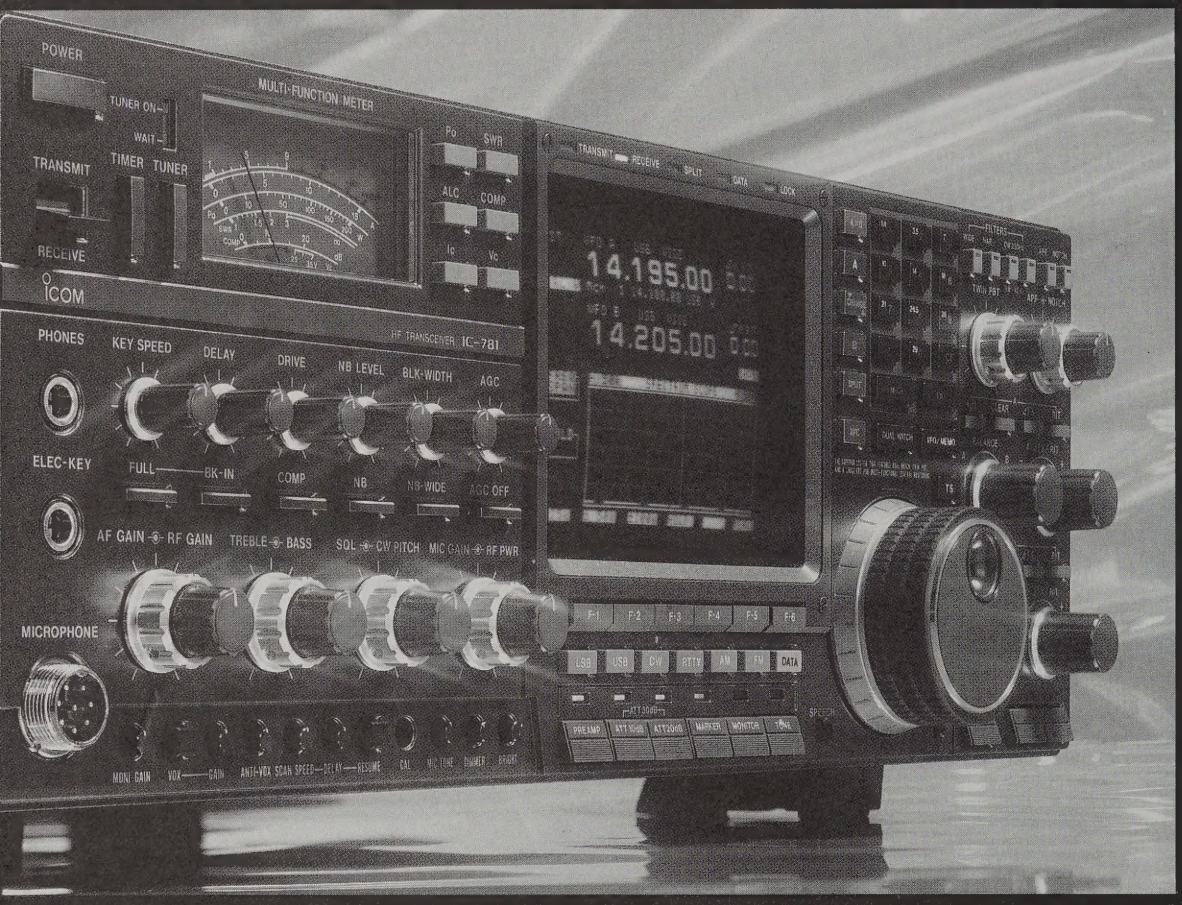
Available from AMSAT Headquarters, 301-589-6062 for $20.00 (add $3.00 postage US, $5.00 Canada/ Mexico, $10.00 South America/Europe, $15.00 elsewhere)



THE LAST WORD IN PERFORMANCE



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